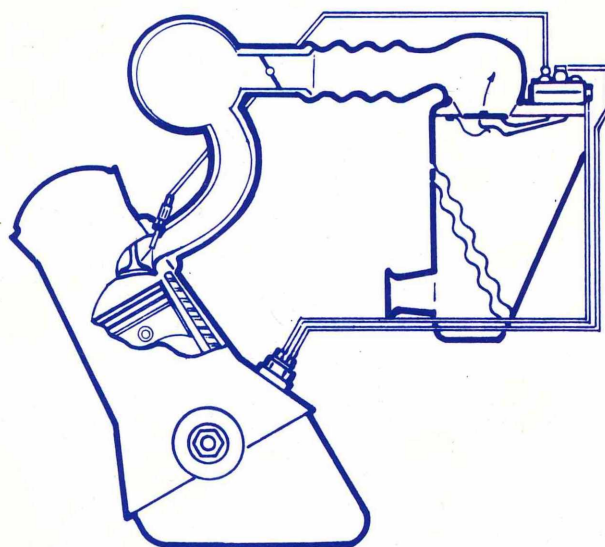
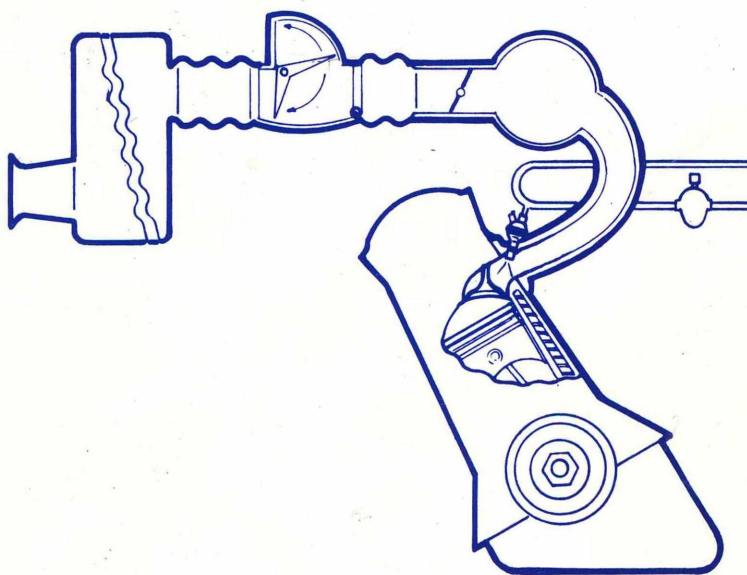


BMW FUEL INJECTION

An Enlightened Approach



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**BMW FUEL INJECTION:
An Enlightened Approach**

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BMW FUEL INJECTION

An Enlightened Viewpoint

When your Fuel-Injected Engine's performance is suffering and you entrust it to your local shop, the mechanic will most likely proceed according to this prescribed method of repair;

- 1) Recognize engine symptoms.
- 2) Decide whether these symptoms are fuel related.
- 3) Pinpoint the fuel system components responsible; and finally...
- 4) Replace the components.

This method relies upon two assumptions. First, that component failure is the cause of fuel injection problems, and second, that replacing these components actually will restore engine performance. Unfortunately, although both assumptions sound sensible, they are, in fact, false. To see this, consider the following. Fuel delivery is based on the intake air volume as measured by the air flow meter. Since the valve cover breather hose is connected to the intake manifold, the crankcase is always under manifold vacuum. Therefore, as the engine ages, unmetered air enters the intake tract past the piston rings (blow by) and through the seals and hoses (vacuum leaks).

The fuel system does not wear in the same way as the engine and since it is incapable of self-correction, fuel delivery very gradually decreases with time. This inevitable "leaning" is responsible for nearly all fuel-related performance problems. It is important to realize that the problems do **not** usually reside in faulty injection components. Rather, they result from changes in engine requirements not sensed by the fuel system. Our approach specifically accounts for this: **the fuel system, just like a clock that has fallen behind, does not need new components - it just needs to be brought up to date.**

In fact, unlike our approach, replacing suspect components with new ones, in most instances, accomplishes nothing! New components are calibrated for new engines, and not for your mature one. Since engine parameters change with age, and with individual engines, there is only one way to restore new engine performance to mature engines: **READJUST the fuel injection system! Bosch has engineered into the design of every major injection component full adjustability!**

Our service manual is a common-sense guide to dealing with fuel injection problems. It differs completely from today's prescribed method of replacing parts. Our method is to adjust rather than replace.

Replacement should not be the first option, but the last! After 10 years of experience, it has proven to be much more effective. More-over, it is workable not just for the mechanic but for any BMW owner who is able to tune his own engine.

We provide you with step-by-step procedures for:

- 1) Determining if the performance problem you are having is fuel related. This is very important because more often than not, poor performance problems are not fuel-related.
- 2) Pinpointing the precise nature of the problem. Here we provide an orderly method for you to discover where, among all the possible places, the problem is located.
- 3) Adjusting, repairing, and as need be, replacing malfunctioning parts.

This service manual is unlike any other you have ever seen. Other manuals do not tell you how to work on your car; they tell you how to replace parts. Their trouble-shooting guides tell you which, of several component, might need replacing, with no discussion of the likelihood of one over the other, or of how these parts can be adjusted.

Becoming an efficient troubleshooter and an effective repairman is what our manual is all about. For each symptom, all possible causes are ranked according to probability of occurrence and ease of diagnosis. This enhances efficiency because the most probable cause is not always the most easiest to check. For example, it pays to spend five minutes checking the ignition timing even if the likelihood of its being the cause of the problem is less than that of some injection component. Imagine spending two hours adjusting the fuel injection system only to learn that resetting the timing was all it needed...and then realize that because of your initial mistake, the fuel injection system must now be re-adjusted. Our aim is to stop you from turning two-hour jobs into two days.

This manual provides the information and methods sufficient to allow the reader to periodically fine tune the fuel injection system and once again synchronize it with the engine, thus bringing performance back to where it belongs.

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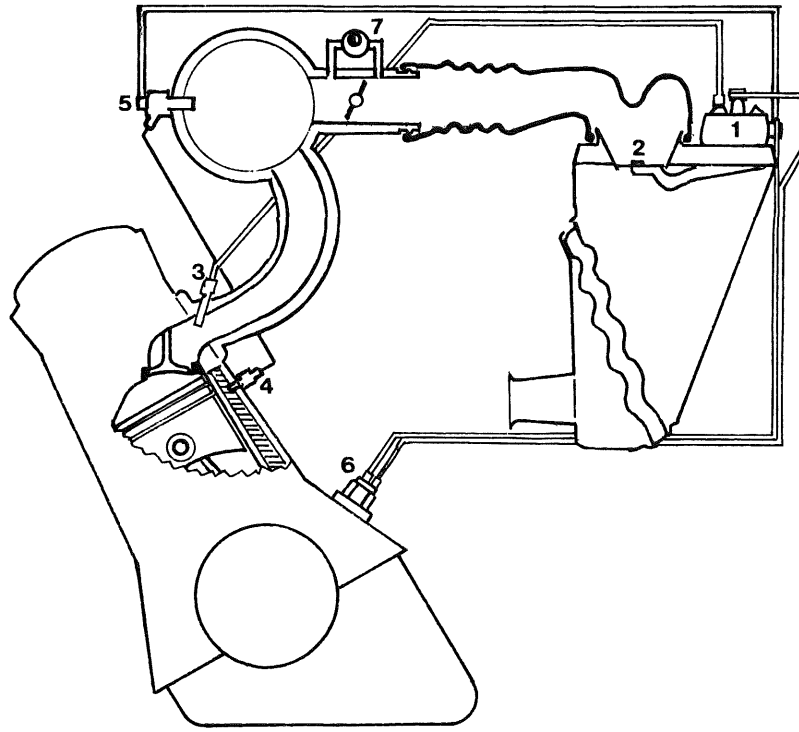
HISTORY

1

Bosch K-Jetronic Continuous Injection System

From the beginning, the heart of Bosch mechanical fuel injection was the high pressure injection pump. Most of these pumps were timed to discharge fuel through a mechanical injector immediately following the opening of the intake valve. These systems could only be found on limited production cars such as Mercedes Benz and Porsche 911. Even the BMW 2002tii from 1972-1974 was equipped with a similar mechanical injection system using a Kugelfischer pump. Both systems are superior for producing horsepower because they register engine rpm and throttle setting. For acceptable emissions, however, a system was needed that measured intake air flow as a way of monitoring the fuel/air mixture.

Bosch's response to this challenge is K-Jetronic mechanical injection -a low pressure continuous flow system - that not only meets low emissions standards but delivers comparable performance and even improved economy. This system first appeared on 1974 Porsche 911's and on Volvo 140 series automobiles. by 1977, BMW introduced K-Jetronic injection on their new 3-series car and it wasn't long before this system became the most popular one used by European manufacturers. Bosch K-Jetronic systems are fitted to all U.S.-spec 320i's, 1977 through 1983, inclusive.



FUEL SUPPLY:

The twin fuel tanks on 320i's are located below the rear seat. The fuel pick-up and return tubes and float assembly are mounted in the passenger tank (as well as the auxiliary fuel pump on 1979 and later models). The electric pump, accumulator (pump pulse damper) and filter are clustered to the rear of the passenger tank next to the differential. From the filter, fuel is pumped to the "heart" of the fuel system - the fuel distributor.

FUEL DELIVERY:

At the fuel distributor (1) supply fuel is divided into primary and secondary (control) fuel. Adjacent to and mechanically connected to the fuel distributor is the air flow flap (2) whose function is to sense the intake air volume of the engine. The position of this flap at any given moment determines the quantity of primary fuel that leaves the fuel distributor for the injectors (3). Once the engine starts, all injectors work constantly until the engine is shut off.

COLD START SYSTEM:

For a cold engine to start and run it needs priming, a richer fuel mixture and additional intake air.

The thermo-time switch (4) and cold start injector (5) are responsible for delivering an initial charge of fuel for starting. The exact quantity of fuel depends on the engine coolant temperature as measured by the switch. By allowing electrical current to pass to the cold start injector for a predetermined time interval, the solenoid activated injector releases primary fuel into the intake manifold.

Cold engine operation is controlled with the warm-up regulator (6), by "bleeding-off" secondary fuel pressure (lowering fuel back pressure above the metering pin), which directly increases the primary fuel volume at the injectors. The warm-up regulator has a thermally controlled orifice that gradually opens (cold) or closes (warm) depending upon engine temperature.

To maintain a higher cold-engine idle, the auxiliary air valve (7) allows additional intake air. This too is a thermally controlled orifice which gradually increases (cold) or decreases (warm) the volume of intake air allowed to bypass the throttle valve.

On all 320i's from (1980 on), oxygen sensors and frequency valves were added to comply with U.S.A. emission standards. Their function is to maintain a prescribed carbon monoxide level in exhaust gases, by varying the fuel system pressure as dictated by the sensor probe in the exhaust pipe.

The specific location and detailed function of the various parts of this fuel system will be forthcoming, after it has been determined what symptoms your BMW suffers from and what specific part(s) of the system needs attention.

TROUBLE-SHOOTING

Preliminary Discussion

5

Prior to using the charts it will be necessary to first discuss specific trouble-shooting techniques and engine running conditions. Diagnosis of all fuel injection problems will depend on the engine's state of tune, exactly what engine symptoms are manifest and under what conditions. Most importantly, however, your role as a keen observer will be instrumental to successful fuel injection problem solving.

You, the driver, are in the most advantageous position for determining changes in your engine's behavior. Already accustomed to your car's running habits, you will be first to detect any changes in performance. Once detected, what remains is to determine the precise conditions under which these symptoms occur and how they deviate from "typical" engine response. These four conditions are as follows:

Engine Temperature:

If you have owned your car for any length of time you have already noticed the position of the needle on the temperature guage after the engine has thoroughly warmed (15 to 30 minutes of constant running). When warm, the needle should rest at or near half-way, or pointing straight up, on the guage and when cold the needle will be all the way left.

As obvious as this may seem, keep in mind that the engine is designed to function most efficiently within a narrow temperature range (180 - 210°F), represented by the center area of the guage. Operation below this range (left of center) demands that additional requirements be met by the cold start system for smooth, acceptable performance.

Any over heating of the engine (right of center) is indicative of mechanical problems of a higher priority and will have to be addressed prior to any fuel injection work.

Therefore, for the purpose of this manual you will only need to make two distinctions with regard to engine temperature. EITHER the engine is considered "cold" when the needle is all the way left or near the blue rectangle on the guage, OR, the engine is considered "warm" when the needle is anywhere between the left-most white mark to the center area or operating temperature position. The importance of this distinction becomes apparent in the following imperative concerning engine temperature and fuel injection:

WARM ENGINE FUEL INJECTION
PROBLEMS MUST BE RESOLVED
PRIOR TO EVEN ATTEMPTING TO
RESOLVE COLD ENGINE FUEL
INJECTION PROBLEMS!

In other words, all efforts to remedy cold start system troubles will be futile, if all warm-engine problems have not already been resolved. What oftentimes is the case is that alleviating warm engine disorders will lessen the severity of, or perhaps remedy, problems with the cold start system, but never in reverse. For this reason, then, warm engine problems always take priority.

Starting Behavior:

For an engine to start, three conditions must be met. First, there must be adequate compression (75 lbs. p.s.i., minimum) which is a function of the proper mechanical condition of the engine itself, for example, valves, valve timing, and rings, etc. Secondly, presence of and proper timing of ignition is required which has to do with the condition of the battery, ignition switch, starter, ignition coil, distributor, spark plugs and all interconnecting circuitry, relays and fuses. Lastly, the proper quantity and atomization of fuel and air must be present, which concerns all components of the fuel injection system.

By far the most probable cause (approximately 80% of the time) of starting problems involves the ignition system. Of the three systems mentioned above, this one requires the most regular maintenance, and for this reason major service (tune-up) procedures involve replacement and adjustment of the ignition components. Approximately 20% of the time, failure to start will be attributable to fuel related causes, and less than 1% of all starting troubles have to do with cylinder compression or other mechanical aspects. Special precautions must be taken to eliminate ignition and mechanical possibilities before considering the fuel injection system.

Ideally, the engine should start in one to four seconds of cranking, unless it is extremely cold, in which case it might take as long as eight seconds. As a method of testing your car's starting ability, use the following procedure:

- 1) Turn the ignition switch to the running or "on" position.
- 2) Check that both "oil" and "gen" lights are glowing brightly.

- 3) With your foot poised over the accelerator, but not pushing it, turn the key to the "start" position, engaging the starter.
- 4) Let the engine "turn over" until you hear (or feel) it begin to start, then simultaneously depress the accelerator enough to momentarily raise the rpm to about 1500.
- 5) This done, remove your foot from the accelerator to test the engine's self-maintained idle.

Idle Characteristics:

A good percentage of fuel injection problems will manifest themselves by interfering with the smoothness and the rpm level of the idle. If the engine is "cold", the rpm should be higher than when "warm" and usually no lower. Most 320i's will cold-idle between 1200 and 1400 rpm for the initial two minutes, at which time there will be an abrupt drop to warm-idle or even slightly lower (1979 320i's tend to idle at or only slightly above "warm " idle rpm through the entire cold-start sequence). Six cylinder models up to early 1980's will cold-idle between 1400 and 1700 rpm, and later models between 1200 and 1400 rpm (approximately 1000 rpm) at least by the time they have warmed to operating temperature.

When trouble-shooting a "cold" engine, as quickly as it starts and you have observed its idling characteristics, you will need to perform a test procedure by "blipping" the accelerator. That is, as swiftly as possible and in one continuous motion, depress the accelerator halfway and remove your foot, quicker than the pedal will remove of its own accord. What you are testing is the immediacy of the engine's response, its smoothness and its willingness to rev freely. It should behave just as it does when "warm", assuming that warm engine performance is correct. That is, there should be no hesitation or stumbling and the engine's response should be instantaneous with accelerator movement and free spirited.

Test-Drive Characteristics:

All remaining fuel injection disorders can be diagnosed by test driving the car. The purpose of this procedure is to examine your engine's responsiveness while "under load" and cruising. Those with automatic transmissions should shift through each gear manually for this procedure.

- 1) With traffic at a minimum on a long stretch of road, accelerate in first gear from a stop (accelerator depressed fully) to a minimum of 4000 rpm.
- 2) Listen and feel for smooth, constantly increasing speed with no jerkiness or hesitation.

- 3) Shift to second gear and again fully depress the accelerator, revving the engine to at least 5000 rpm.
- 4) If you do feel any hesitation or lurching, repeat the above steps enough times to determine the consistency and rpm level of the symptoms.
- 5) In addition, note any particular rpm at which the engine "struggles" or refuses to reach (max. 6400 rpm)
- 6) Finally, at some point in the test-drive, in third or fourth gear, "cruise" in the car. That is, on level terrain, hold the accelerator to maintain a constant velocity. The engine should run very smoothly with no jerkiness.

Now that you have completed the start-up, idle and test-drive procedures, carefully observing your engine's behavior, you are nearly prepared for diagnosing in accordance with the trouble-shooting charts that follow. Before doing so, there are three very important considerations:

- 1) YOUR CAR IS THE VERY BEST DIAGNOSTIC TOOL AVAILABLE. There are specific running symptoms for each and every fuel injection flaw that can occur and your familiarity with your engine's behavior will manifest them. Don't think that because you do not have access to a state-of-the-art diagnostic machine that you will be unable to completely maintain your fuel injection system. These machines are limited by a) the selection of components that can be checked, b) how components are judged to be "defective" -i.e. there is no distinction made between "out of adjustment" and "defective", and c) its inability to perform test-drive diagnosis, which ultimately rests in the hands of the person behind the wheel.
- 2) Beware of the phrase - "That's just the way these cars run". If you have doubts about your car's performance, have your trusted friend and/or mechanic test it. Better still, test drive the same model belonging to someone else, to give yourself comparative data.
- 3) We cannot overstress the fact that many of the symptoms you will experience will be attributable to ignition and mechanical problems and not just fuel injection ones. In most instances, a quick check of these non fuel-related probable causes will facilitate trouble-shooting and repairing your fuel injection.

To assist you in pinpointing the cause of your engine's problems, the following guide is divided into three charts, each with its own specific application. These three are mutually exclusive, so carefully chose the one chart applicable to your situation.

Chart #1

Use this table if and only if your engine refuses to start, for any reason. (The one exception to this rule would be the instance of a 320i with a faulty fuel pump check valve that would require 20 to 40 seconds of cranking to start when warm.) You will notice that by far the majority of causes for not starting relate to ignition conditions and for this reason, related test procedures should be given priority to those concerning the fuel system.

Charts #2 and #3

Although quite similar, these two charts vastly differ with respect to the temperature of the engine during symptomatic behavior. Confusing a "cold" engine with a "warm" one will lead to unsuccessful results. If unsure of this distinction, refer to the "Preliminary Discussion" that proceeds this section.

We have two final suggestions:

- 1) For any given set of "causes", in the last column of charts #2 and #3, there is an assigned probability (in percent form) to each particular cause as being the one solely responsible for the particular symptoms observed. It follows that the cause with the highest percentage will be the most likely one to investigate, but there is another consideration. Some causes are easier to trouble-shoot than others, even if they are less likely. Therefore, we have listed the causes in order of "ease-of-testing", while at the same time giving you their likelihood of being the source of the trouble.
- 2) If your engine runs rough and has poor performance, your first procedure should be to perform a minor tune-up. The cost of a set of Bosch points, plugs and a condensor is nominal compared to the possible results in improved performance. As a rule:

YOU WILL RESOLVE HALF OF YOUR RUNNING OR STARTING PROBLEMS, REGARDLESS OF THE SYMPTOMS, BY CORRECTLY REPLACING THE POINTS, SPARK PLUGS AND SETTING THE TIMING OF YOUR ENGINE, BEFORE TROUBLE-SHOOTING THE FUEL SYSTEM.

TROUBLE-SHOOTING CHART #1 STARTING PROBLEMS

<u>STARTING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
When key is turned to "start" position engine will not turn over	Battery is dead or weak	80%	When jump starting, attach jumper cables to auxiliary terminals on plastic factory clamps. Consider replacing any battery that is four years or older as much of its cranking power is gone.
	Battery cables corroded between posts and clamps	16%	Inspect for dark gray or black surface on battery posts and inside of cable clamps. Cut clamps off and replace <u>or</u> remove and clean until contact surfaces shine. Reconnect clamps and tighten. Remove and clean body and engine grounds. Remove and reclean battery clamps and posts, replace and retighten.
	Starter connection(s) or solenoid problems	2%	Inspect solenoid for loose connections at battery terminal (battery cable attached), ignition switch terminal (larger push on) and injection terminal (smaller push-on). Recrimp if necessary. As a test, use a screwdriver blade to connect ignition switch terminal to battery terminal on the solenoid, bypassing the ignition switch.
	Ignition switch defective	1%	With a screwdriver blade, connect ignition switch terminal to battery terminal on solenoid, bypassing the ignition switch. Also use a test light to verify current at ignition switch terminal wire with key in "start" position.
Starter engages, but engine turns over slowly	Battery weak &/or connections corroded	85%	See above procedures.

TROUBLE-SHOOTING CHART #1
STARTING PROBLEMS
Continued

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<u>STARTING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
(Continued)	Starter "drags" (battery charged)	12%	Starter rear bushing support (composed of nylon) for armature worn. Replace starter or fabricate replacement bushing.
	Engine oil too thick (cold weather)	2%	Replace with multiple viscosity oil (10W-40 or 20W-50)
Engine turns over well but refuses to start	Fuel pump not activating	25%	While someone else turns over the engine, listen for fuel pump humming sound underneath car just outside right rear wheel. If no sound, inspect: Air flow meter door restriction; Air flow meter electronic connection; Massive intake leak, e.g. split intake bellows; Double relay and connections; Fuel pump connections & fuse
	Ignition system breakdown between positive coil terminal and high tension coil wire	75%	Remove coil wire from distributor cap. Insert screwdriver blade into plug wire end while holding blade 3/4 - 1" from a ground (e.g. valve cover). An intense blue-white spark should occur. If spark is weak, intermittent or not present, replace points and condenser. Also inspect coil wire resistance, corrosion under coil wire boots, the center electrode inside distributor cap for wear or absence, defective rotor, current at positive coil terminal or points contact's for obstruction. (Those with electronic ignition refer to Factory Manual).

TROUBLE-SHOOTING CHART #1

STARTING PROBLEMS

Continued

STARTING SYMPTOMS	PRIORITIZED CAUSES	%	SOURCES OF PROBLEMS/REMEDIES
(Continued)			
Special Conditions	Moisture obstructing ignition (wet or high humidity conditions)	100%	Dry ignition with moisture displacer, hair dryer, rag, etc., from points, distributor cap, plug wires and boots, coil and coil wire.
	Engine "flooded" - spark plugs fuel soaked (cold engine)	100%	Three conditions cause fuel to foul spark plugs: Too much fuel to adequately vaporize Temperature too cold for adequate vaporization Voltage drop at primary side of ignition, causing weak spark.
Engine starts <u>only</u> after prolonged cranking	Fuel pressure initially too low (warm engine)	100%	Replace fuel pump check valve (Fuel Pump Section)
	Fuel mixture initially too lean (cold engine)	100%	Inspect thermo-time switch/cold start valve circuit (See Section)

BEFORE REFERRING TO CHART # 2, The Ignition System Must Pass This Definitive Test:

Remove plug wire from spark plug and insert tip of screwdriver into plug insulator, holding screwdriver shank no closer than 1/4" from a ground (valve cover cap nuts) turn ignition to "start" position and inspect for bright, blue-white spark, sufficiently intense (fat) to bridge gap of 3/4 - 1". Remove spark plug, reconnect plug wire, ground spark plug and turn ignition to "start".

IF spark observed is rhythmic and adequately intense, refer to Chart #2

IF spark observed is weak (yellow/orange), intermittent or not present, repeat Chart #1 procedures.

TROUBLE-SHOOTING CHART #2
K-JETRONIC FUEL INJECTION
Engine Temperature - Warm

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<u>STARTING, IDLING & PERFORMANCE SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Refuses to start - regardless of length of cranking time	Ignition breakdown	65%	Remove a spark plug then reconnect the spark plug wire. While grounding this plug to the valve cover, turn the ignition to "start". -If the spark is rhythmic and intense (blue-white), the ignition is satisfactory. -If the spark is intermittent, weak (yellow-orange) or not even present, refer to CHART #1.
	No fuel delivery	30%	Test fuel pump fuse first, then refer to Fuel Pump section
	Fuel mixture extremely lean	4%	Inspect underside of intake air boot for a split in the bellows or similar large intake leak(s). (see Intake Leak section)
Will not start unless engine is cranked for 20 to 30 seconds (within 30 minutes of last engine operation) with idle initially low and stumbly, then smooth	Inadequate fuel pressure	84%	Fuel pump check valve not maintaining residual fuel pressure for required 30 minutes. (see Fuel Pump section)
	Inadequate fuel delivery at individual cylinder(s)	15%	Injector(s) leaking. (see Fuel Injectors section)

TROUBLE-SHOOTING CHART #2
K-JETRONIC FUEL INJECTION
Engine Temperature - Warm
Continued

<u>STARTING, IDLING & PERFORMANCE SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Starts poorly or starts then dies with General loss of power and/or refusal to rev over a certain rpm.			
a) Idle - low but smooth	Timing too retarded	30%	Inspect points for signs of wear and proper gap (.016") and reset timing to "Z" and not "TO" ball on flywheel (long peg, not short for automatic transmissions).
	Incorrect fuel mixture	30%	Metering pin lodged in fuel distributor (see section)
	Fuel delivery restriction	19%	Injectors partially restricted. (see Fuel Injectors sect.)
b) Idle - low and rough with <u>rythmic</u> miss (as if one cylinder is missing)	Ignition breakdown between distributor cap and spark plugs Ignition timing too advanced	54%	With engine idling, remove all spark plug wires <u>one at a time</u> . Each deactivated cylinder should cause a distinct drop in idle rpm. If there is no idle change that cylinder is not firing. Inspect for fouled spark plug(s). Test plug wire and insulator for excessive resistance (substitute a working wire). Inspect inside of distributor cap for cracks or carbon tracks.
	No fuel delivery to cylinder(s)	10%	Differential valve failure. (see Fuel Distributor sect.)
	No fuel delivery at individual cylinder(s)	19%	Injector(s) totally restricted or leaking (see Fuel Injector section)

TROUBLE-SHOOTING CHART #2
K-JETRONIC FUEL INJECTION
Engine Temperature - Warm
Continued

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<u>STARTING, IDLING & PERFORMANCE SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
	Vacuum leak	15%	Inspect intake runner gaskets and all connecting vacuum take-offs for the missing cylinder.
	Inadequate cylinder(s) compression	1%	Test cylinder compression for a minimum of 75 psi
Starts normally with excessively high idle	Timing too advanced	50%	Reset distributor timing Check distributor mechanical advance Inspect distributor vacuum retard line(s)
	Throttle opened too far	40%	Inspect throttle arm and return springs for freedom of movement.
	Excessive amount of throttle bypass air flow	10%	Throttle stop set incorrectly Test deceleration valve operation (Aux. Air Valve section) Test auxiliary air valve (see section) Minor intake leaks
Starts normally with weak idle and is slightly hesitant during acceleration and/or jerky while cruising	Fuel mixture too lean	80%	Reset CO adjustment (CO/Fuel Mixture section) Check for intake leaks (Intake leak section)
	Inadequate fuel delivery	19%	Fuel filter partially restricted (Fuel Pump section) Vapor lock (hot weather) - remove gas cap for ventilation.
	Ignition weak	1%	Weak coil or faulty condenser.

TROUBLE-SHOOTING CHART #2
K-JETRONIC FUEL INJECTION
 Engine Temperature - Warm
 Continued

<u>STARTING, IDLING & PERFORMANCE SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Starts normally with rythmically oscillating idle and possible run-on in hot weather	Fuel mixture too rich	99%	Reset CO adjustment (Fuel Mixture section) Oxygen sensor defective (see section)

TROUBLE-SHOOTING CHART #3
K-JETRONIC FUEL INJECTION
Engine Temperature - Cold

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<u>STARTING, IDLING & PERFORMANCE SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Refuses to start - regardless of length of cranking time	No fuel delivery	20%	Test fuel pump fuse for resistance, then refer to Fuel Pump section
	Ignition breakdown	74%	Remove a spark plug then reconnect the spark plug wire. While grounding this plug to the valve cover, turn the ignition to the "start" position. -If the spark is rhythmic <u>and</u> intense (blue-white), the ignition is satisfactory. -If the spark is intermittent, weak (yellow-orange) <u>or</u> not even present, refer to CHART #1.
	Fuel mixture extremely lean	5%	Inspect underside of intake air boot for a split in the bellows or similar large intake leak(s). (see Intake Leak section)
Refuses to start - specifically after intake manifold backfire	Fuel mixture extremely rich	100%	Metering pin lodged in fuel distributor Air flap distorted and/or lodged in housing (see Fuel Distributor section)
Refuses to start- especially under humid or rainy conditions	Ignition breakdown due to moisture	100%	Remove moisture from points, distributor cap, spark plug wires, and all coil and boot-covered connections.

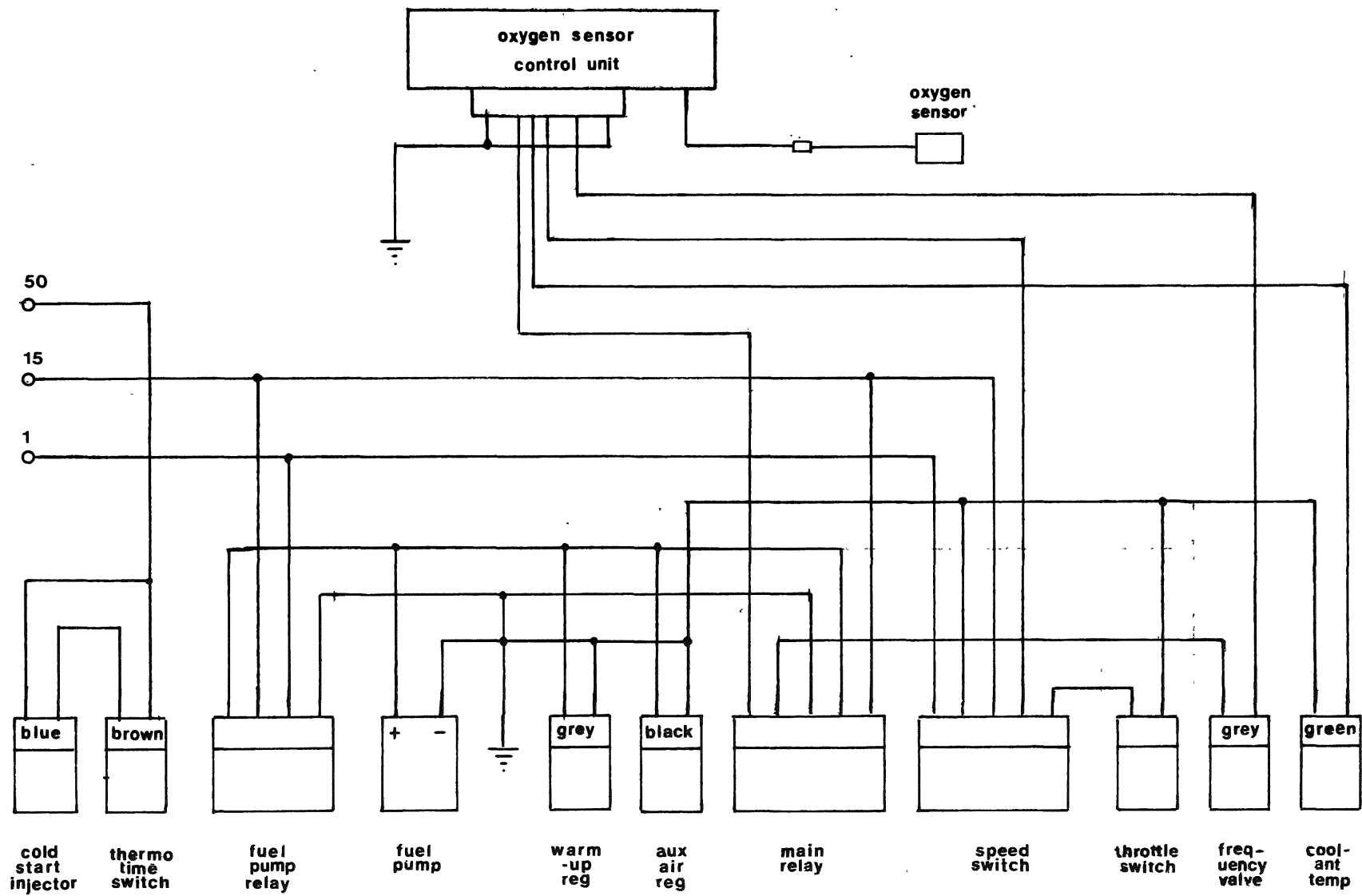
TROUBLE-SHOOTING CHART #3
K-JETRONIC FUEL INJECTION
 Engine Temperature - Cold
 Continued

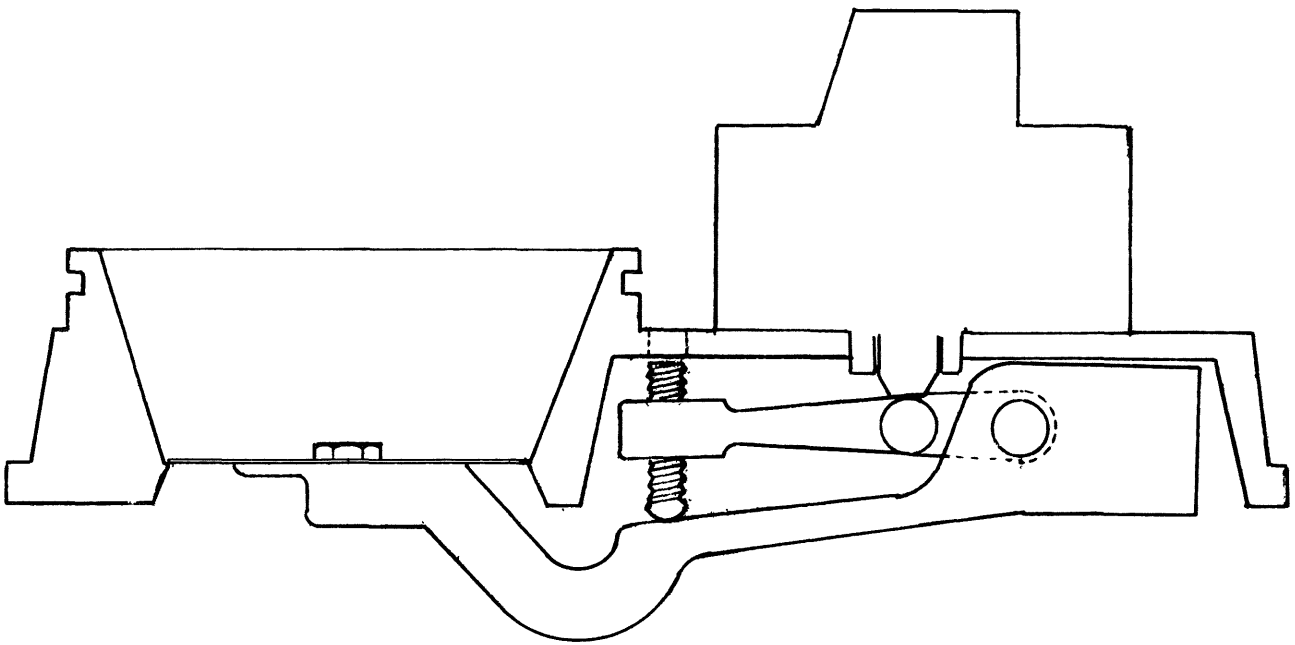
<u>STARTING, IDLING & PERFORMANCE SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Starts and idles briefly, then dies	No fuel delivery	40%	Replace fuel pump fuse, if problem still exists refer to Fuel Pump section.
	Fuel mixture extremely lean	59%	Massive intake air leak(s). Check underside of intake air boot for split in bellows. (see Intake Leaks section) Warm-up regulator severely out of adjustment (see Warm-up Regulator section)
Starts normally with smooth idle , but low cold-engine rpm			
a) Normal throttle response	Inadequate quantity of throttle bypass air flow	59%	Auxiliary air valve restricting cold engine idle air flow (see Auxiliary Air Valve section)
	Fuel mixture slightly lean	40%	Warm-up regulator slightly out of adjustment. (see Warm-up Regulator section)
b) Delayed throttle response (possible intake manifold backfiring	Fuel mixture too lean	100%	Warm-up regulator slightly out of adjustment. (see Warm-up Regulator section)
c) Stumbling, labored revving	Fuel delivery inadequate	100%	Fuel injector(s) restricted. (see Fuel Injectors section)

TROUBLE-SHOOTING CHART #3
K-JETRONIC FUEL INJECTION
Engine Temperature - Cold
Continued

20

<u>STARTING, IDLING & PERFORMANCE SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Starts only after prolonged cranking with idle initially rough	Fuel mixture too lean	97%	Cold start valve's failure to activate at temperatures below 50°F. (see Thermo-Time Switch/Cold Start Injector section).
	Coolant in combustion chamber(s)	2%	Cylinder head cracked (also evidenced by sweet smelling, white colored exhaust during initial idling)
Reluctant starting with idle rythmically rough and delayed throttle response, labored revving	Ignition breakdown at individual cylinder(s)	85%	By removing plug wires from spark plugs, <u>one at a time</u> , locate the cylinder with the least effect on idle rpm. Inspect distributor cap for cracks and carbon tracks. Spark plug(s) completely fouled. Inspect for excessive electrode wear, deposits and/or wetness. Test resistance in spark plug wire(s) and resistor(s).
	Loss of fuel delivery	5%	Differential valve(s) prohibiting fuel flow (see Fuel Distributor section)
As above, but normal performance once started	Initially low injector line pressure	9%	Injector(s) leaking (see Fuel Injector section)

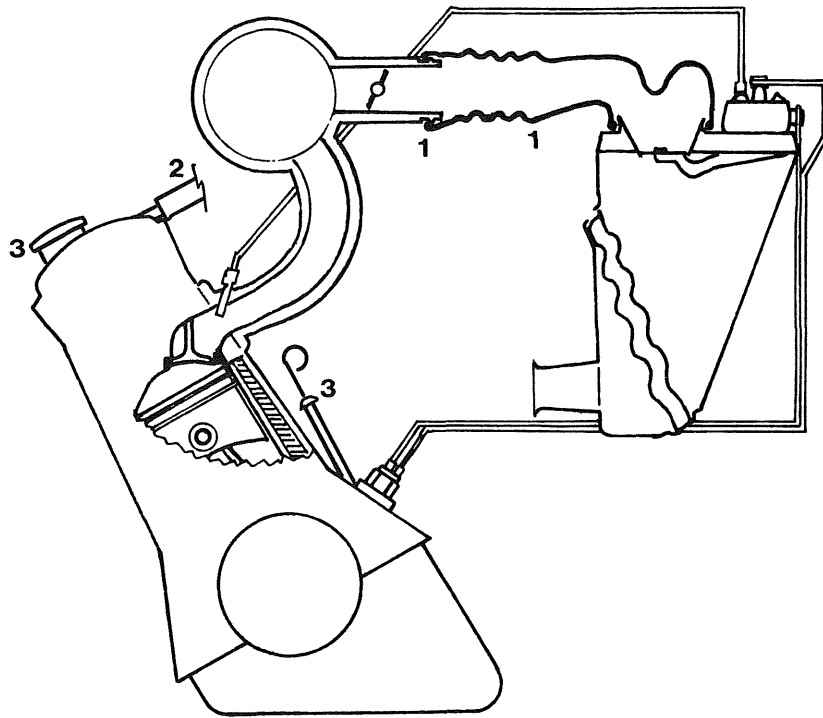


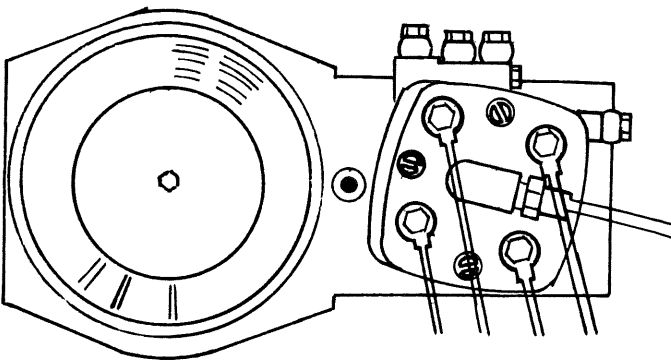


Intake leaks are not only difficult to locate, but even harder to diagnose. A small leak (e.g. a leak in one of the smaller silicone vacuum lines), causes the idle rpm to raise or lower depending on how rich or lean the CO (fuel mixture) is set. Large intake leaks are usually easier to locate and will always affect starting, idling, and performance especially when the engine is warm.

Despite the dozens of possible hidden places that intake leaks can occur, you will, in all probability, discover the leak in one of the following three locations:

- 1) Intake Boot - On 1977-79 models the rubber boot connecting the air flow housing to the throttle body will eventually split on the underside of the bellows part of the boot. Unless the engine backfires thru the intake manifold when starting a cold engine, oftentimes it is mostly due to the natural deterioration of the rubber composite. Also check the clamps on the boot for secure connections. First you will notice a general loss of power and more difficult starting, until finally the engine will refuse to rev over a certain rpm or run all together.
- 2) Breather Hose - There is a hose that runs from the valve cover to the intake boot that carries crankcase fumes to be burned before being released into the atmosphere. In 1977-79 models it is, by design, difficult to remove and replace and since it is necessary to detach it when adjusting the valves it's not long before it is cracked and split. Since this hose is directly attached to the intake system and the engine crankcase is under a slight vacuum, any broken seals will lean the fuel mixture. The best preventative maintenance would be to replace the breather hose when it becomes brittle or cracked.
- 3) Oil Dipstick/Oil Cap - Even as simple a job as changing the oil or checking the oil level can cause the engine to run so badly that you might think the whole fuel injection system has failed at once. It might even prevent the engine from running all together if either the dipstick has not been seated down in the tube fully and/or the oil cap has been put on incorrectly or not tightened sufficiently. As ridiculous as it might seem, this happens quite often.



PART FUEL DISTRIBUTOR	PRIMARY SYSTEM
ILLUSTRATION 	ELECTRICAL CONNECTOR Identification and color code
PART NUMBERS Fuel distributor... 1977-1979 Bosch/Exchange FD18X (Rebuilt) 1980-1983 Bosch/Exchange FD34X	COMMENTS

FUEL DISTRIBUTOR

Location and Description:

The fuel distributor is a rectangular, black box with nine fuel lines connected to it, that is in plain view from the driver's side of the engine compartment. On 1977-79 models, it is located directly above the air filter housing, just behind the battery and in front of the air intake boot. On 1980-83 320i's the fuel distributor sits under the front half of the intake manifold (under #1 and #2 intake runners).

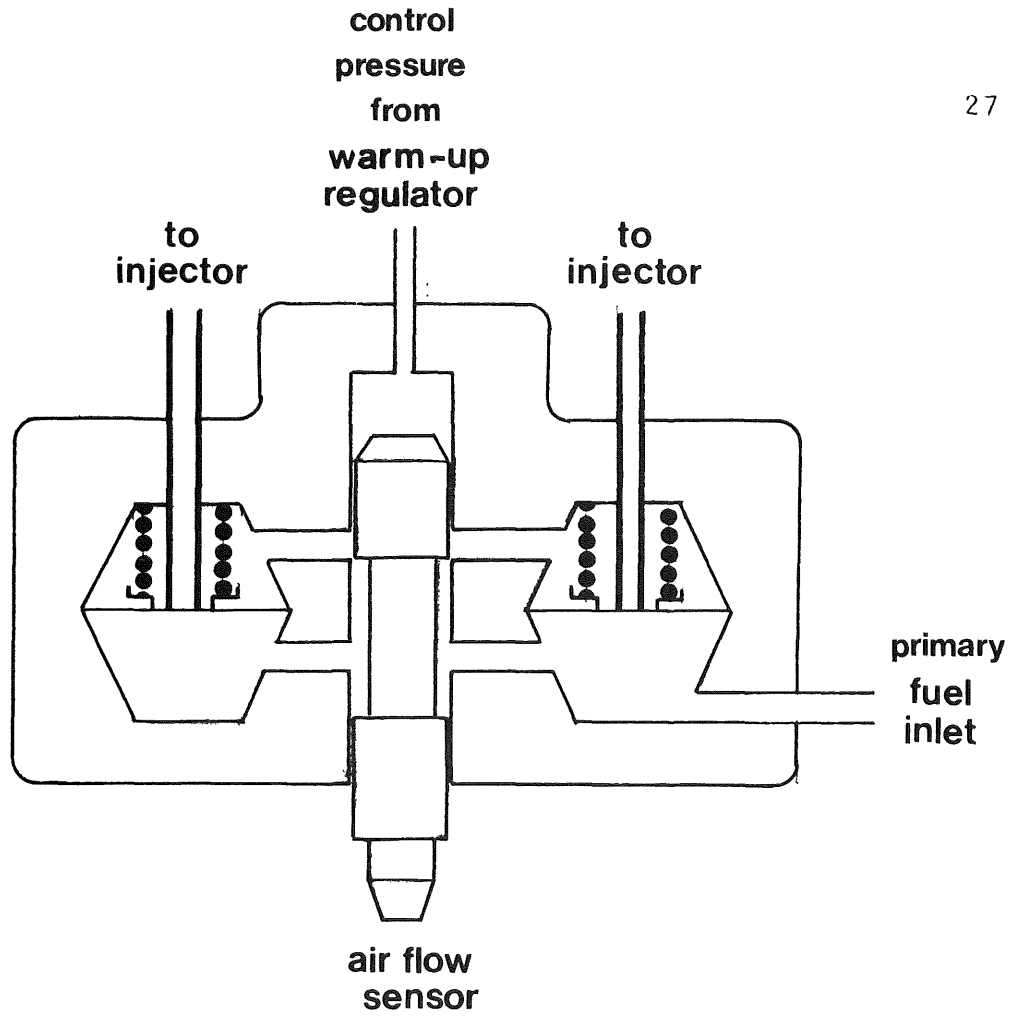
Function:

As its name implies, the fuel distributor allocates precisely equal quantities of pressurized bulk fuel, supplied by the fuel pump, to each of four injector lines. This is accomplished by separating the inlet fuel into two chambers, via restriction passages, which results in a 0.1 bar (1.5 psi) pressure difference between the two fluids. The higher pressure (primary) fuel is delivered to the injectors while the lower pressure (control) fuel opposes the flow of the primary fuel supply.

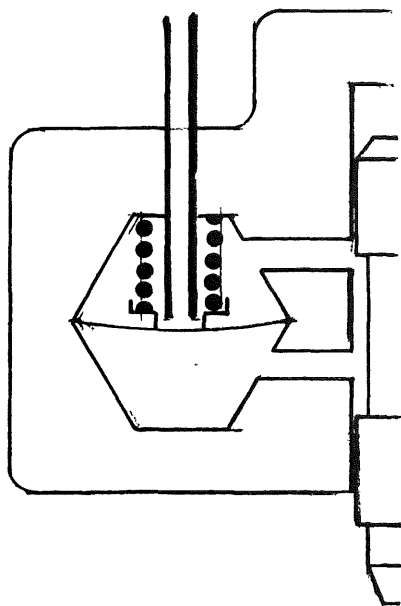
The heart of the fuel distributor is the metering pin, or precisely machined shaft that restricts the flow of primary fuel supply into each of four chambers, through four "slits" (long narrow openings) in the metering pin barrel. As the primary fuel fills the narrowed middle of the metering pin, forcing it up to uncover the metering slits that lead to the individual injector chambers, the control supply forces the metering pin down with nearly equal force, preventing the pin from moving up by mere fuel pressure alone. This elaborate design is simply to allow pressurized fuel to flow with just the slightest amount of lifting force on the metering pin itself. This force is provided by the lever in the air flow meter, upon which the pin rests, that is raised by the force of intake air movement on a circular disc through a specially designed orifice.

In each of the four injector chambers inside the fuel distributor is a differential valve, the top half of which contains primary fuel at normal pressure while the bottom half contains primary fuel at a slightly lower pressure. This valve assures the delivery of a sufficient flow of primary fuel by maintaining a fuel back pressure directed against and at least equal to the opening threshold pressure of each injector.

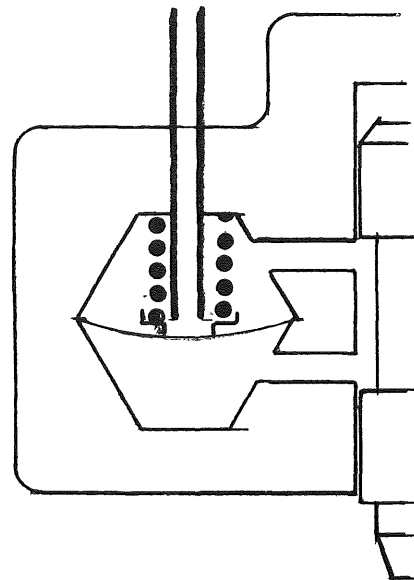
Adjustments or repairs to the internal workings of the fuel distributor are for the most part beyond the scope of this manual. However, the metering pin is serviceable.



Differential Valves



air flap partially raised:
moderate fuel flow



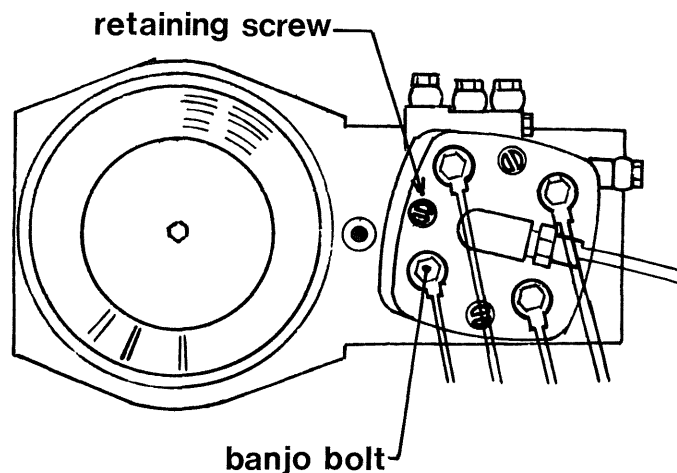
air flap fully raised:
maximum fuel flow

Metering Pin:

Occasionally the metering pin will lodge inside the fuel distributor in the "full-throttle" position. This will cause the engine to not start (especially after an initial backfire in the intake manifold) and if cranked over, will soak the spark plugs enough to prevent starting entirely. Evidence of a sticking metering pin is an engine that seems to abruptly run out of power at a particular rpm (similar to the effect of a rev-limiter in the distributor), in spite of a smooth idle and good acceleration. The following procedure will resolve both types of problems.

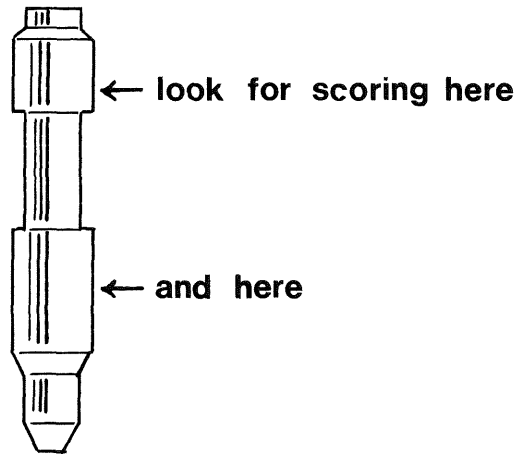
Cleaning and Reclearancing the Metering Pin:

1) Looking at the top of the fuel distributor, you will notice three screw heads. Using the largest straight blade screwdriver you have, (these bolts are often very tight) remove them. You might find it necessary to loosen some of the fuel injection lines in order to get a straight shot at the bolt heads.



2) Once loosened, pull up on the distributor as much as possible while simultaneously twisting it about 45° to 60° in order to see the underside where the metering pin is positioned. Using only your fingers, grab the bottom of the pin and pull it out of its bore. If your diagnosis is correct it will be, at the very least, stiff and possibly

wedged tightly. **IMPORTANT** - under no circumstances should you use pliers, hammer, screwdrivers or any metal objects to dislodge the pin. It is a precision made part that, even if dropped, could be ruined.



3) When removed, closely examine the pin for scoring marks. If there are none, go on to step #4. If score marks are present, take a piece of extremely fine sandpaper (600 grit or finer) or crocus cloth, wrap it around the pin and gingerly spin it in your hand. The objective is simply to repolish the surface where the score marks appear, and nothing more. Under no circumstances do you want to remove any metal.

4) Take a spray can of carburetor cleaner (e.g. Zep, Gumout) and douse the pin thoroughly to remove any foreign matter. Now liberally spray the carburetor cleaner up into the barrel in which the pin rides. Don't be stingy, spray plenty of solvent three or four times. This will remove fuel varnish from the shaft.

5) Making sure that both the metering pin and shaft are as clean as possible of everything (carburetor cleaner wetness is acceptable) slide the pin gently up into the hole, being careful not to force it. There should only be the very slightest amount of drag.

6) Holding the distributor right side up, slide the pin up and down four or five times to make sure there is no sticking. If the fit is right, the pin will slowly fall under its own weight. If not, repeat the previous three steps.

7) Before remounting the distributor, locate the O-ring that sits in the circular groove on the housing to which the distributor bolts. Position the O-ring in place (use a little grease if desired), hold the pin all the way up into the distributor and, in one quick motion, lower onto the housing. Refit the three screws, tightening evenly, and the tighten any fittings that were also loosened.

8) Now you're ready to test drive the car. If your problem is solved, you need to reset the CO or fuel mixture (following section). If not, continue.

Differential Valve(s):

Inside the fuel distributor are four valves that are responsible for the delivery of fuel to each of the four injection lines. Occasionally one (seldom two simultaneously) of these valves malfunctions causing the engine to run on only three cylinders. This will be most obvious at idle when the rpm are lowest. You will notice a very steady, rhythmic miss in the engine, and a definite loss of power at all rpm.

Pinpointing the Problem:

1) With the engine idling, you will be loosening each of the four banjo bolts attaching the injector lines, to the top of the fuel distributor, one at a time.

2) With a 13mm wrench, loosen the first bolt 1/4 of a turn and listen for the idle rpm to drop and the engine to run rougher than it already is. You should see fuel spill out from the fitting as you do this. Repeat for all four bolts.

3) There should have been one bolt that, when loosened, neither dropped the idle rpm nor caused the engine to run any rougher. If you're not sure repeat step #2 again, looking for the one bolt that has no effect on the engine's idle.

4) When you find the line at fault, while engine still idles, remove the banjo bolt and two sealing washers entirely and place your thumb over the exposed hole, on the fuel distributor, to provide the necessary back pressure needed to activate the differential valve.

5) If the differential valve is defective, you will easily be able to completely stop the flow of fuel with moderate pressure from your thumb. In extreme cases, there will be no fuel flow at all. If either is the case, you have discovered a defective fuel distributor.

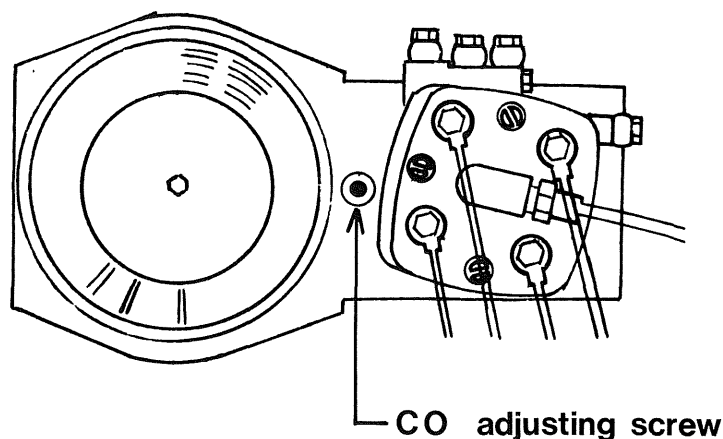
6) If you can easily stop the fuel flow with your thumb, your fuel distributor will have to be replaced. If, however, you cannot stop the fuel flow with moderate thumb pressure, the fault now lies in the corresponding injector, or once in a great while, a restriction in the injection line itself. Before removing injectors, once again test for a non fuel-related problem (see CHART #1).

THE CO (FUEL/AIR MIXTURE) ADJUSTMENT

Ideally the mixture can be set when the engine is either warm or cold, however, this assumes that your fuel injection system is otherwise functioning normally. For consistent accuracy wait until the engine reaches operating temperature to adjust the fuel mixture. It would also be advisable to check for possible intake leaks first because such a leak would give a false fuel mixture reading. Remember, despite the simplicity of the adjustment procedure, the CO setting is the master control for fuel mixture not only at idle but through the entire rpm range, regardless of engine temperature.

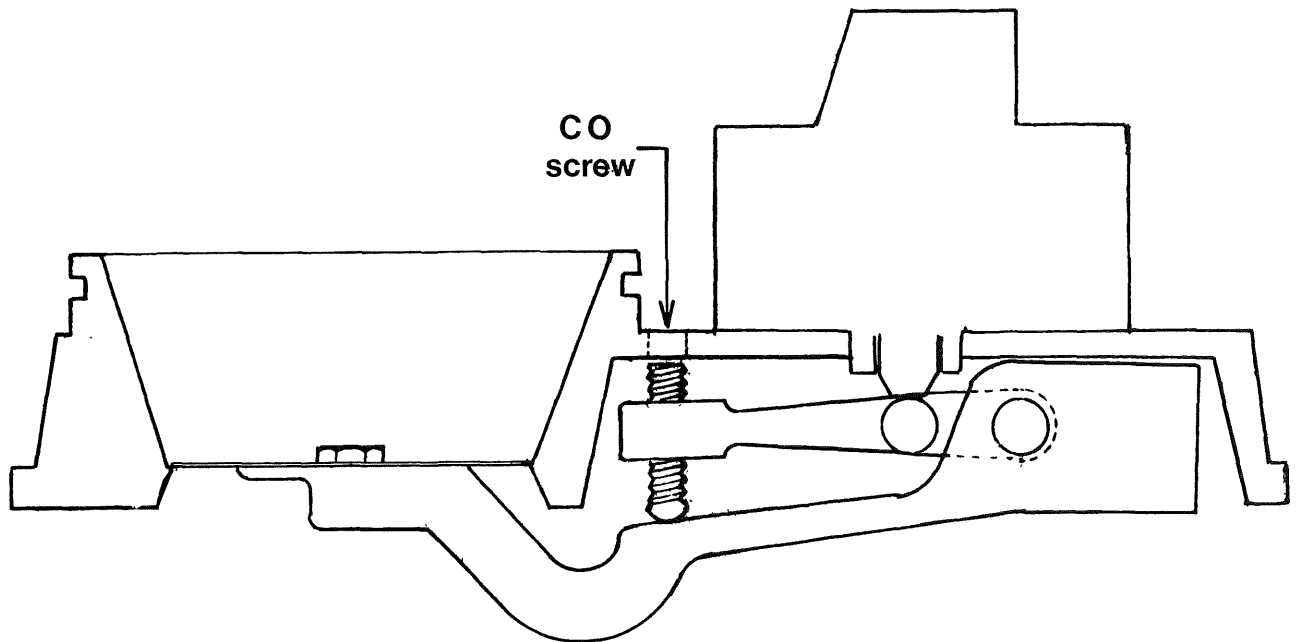
Location:

First locate the fuel distributor - the black, rectangular metal "box" with nine fuel lines attached to it. It is directly above the air filter cannister bolted to the aluminum air flow housing. On 1980-83 models the fuel distributor can be found below #1 intake runner. Next to it is the intake air boot that connects the air flow housing to the throttle housing on the engine. Between the distributor and the intake boot is a small hole (6mm) and just below the hole is a 3mm socket head screw. This is the CO or fuel mixture screw.



Function:

This screw is threaded through a short lever, while the tip of the screw rests on another longer lever. Resting on the shorter lever, between the screw and its fulcrum, is the metering pin which exposes



four narrow "slits" in its own bore for fuel delivery. The longer lever pivots on the same fulcrum and opposite this fulcrum is a circular disc called the air flap.

The flap rests at the bottom of a specially designed chamber. A given air flow through this chamber causes a corresponding lift of the air flap.

The unique shape of the air flow chamber and the dimensions of the metering "slits" in the fuel distributor bore represent a direct relationship between the amount of air flow and fuel delivery at any given rpm. Since both levers pivot on a common fulcrum, turning the mixture screw changes the position of the metering pin (short lever) with respect to the air flap (long lever). By turning the mixture screw clockwise the metering pin is forced up into the fuel distributor exposing more metering "slit" cross-section, allowing a greater quantity of fuel to reach the injectors. Likewise, a counter-clockwise turn lowers the metering pin, blocking more of the metering "slits", restricting the amount of fuel delivered for any given volume of air.

34 Adjustment:

You will need a 3mm T-handle allen wrench (also called a CO Bar) twelve inches or longer for 1980-83 models and a straight blade screwdriver to make CO and idle adjustments, respectively.

- 1) Start the engine and let it idle until warm (midway on the temperature guage). Leave the car in Neutral or Park with the air conditioning off.
- 2) Insert the 3mm bar into the CO screw hole until you feel it slip into the head of the screw.

1977 - 79

- 3a) Now turn the bar clockwise slowly until the engine rpm drops, then counter-clockwise until the idle drops again.

1980 - 83

- 3b) Unplug the oxygen sensor at the connection on the inner fender.

3c) Before turning the mixture screw, locate the frequency valve sandwiched between the fuel distributor and the engine block. Listen closely for a "buzzing" sound emitting from this valve. If you cannot identify this sound, grasp the fuel line loop that connects this valve with the fuel distributor and feel the valve vibrating.

3d) Turn the CO bar clockwise while listening (or feeling) for a constant vibration in the frequency valve. Within one full turn the valve will alternately stop vibrating, then start again and if turned far enough will stop vibrating completely. Now turn the bar counter-clockwise noting the position at which the frequency valve operates constantly.

3e) Continue turning counter-clockwise until the point at which the valve again begins vibrating intermittently, then reverse direction noting at what point the valve once again vibrates constantly.

All Models

4) The distance between these two points (approx. 1/2 turn) represents the correct fuel mixture boundaries for your engine. Now turn the CO screw to the position of best idle: highest rpm & smoothest operation. Usually, the optimum setting is half-way between these determined boundaries.

- 5) Reconnect the oxygen sensor

All Models

6) With your screwdriver, set the idle at or near 1000 rpm. The idle air bypass screw is 12mm in diameter and located on the right side of the throttle body (the aluminum housing protruding between #2 and #3 semi-circular intake runners) closest to #3 intake runner on 1977-79 models. On late models you will find the idle screw by looking over the valve cover from the passenger side of the engine compartment, directly under the rectangular, central section of the intake manifold.

1977 - 79

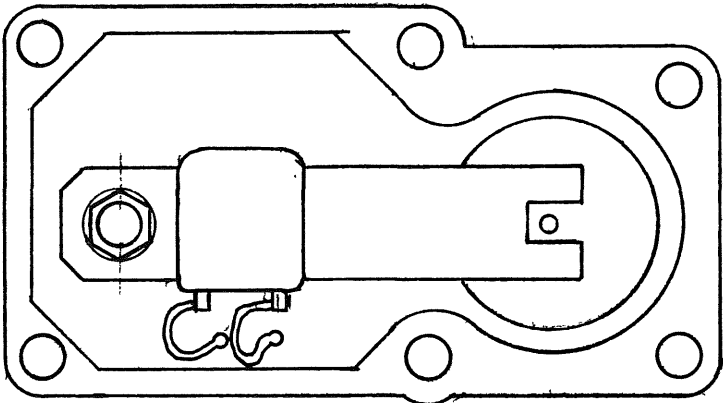
7a) As a test "blip" the throttle quickly (to approx. 3000 rpm) and listen for the idle to gradually return to 1000 rpm. If the idle first drops below 1000 rpm then returns to normal, the mixture setting is too rich and you will need to turn the CO screw slightly counter-clockwise and repeat this test.

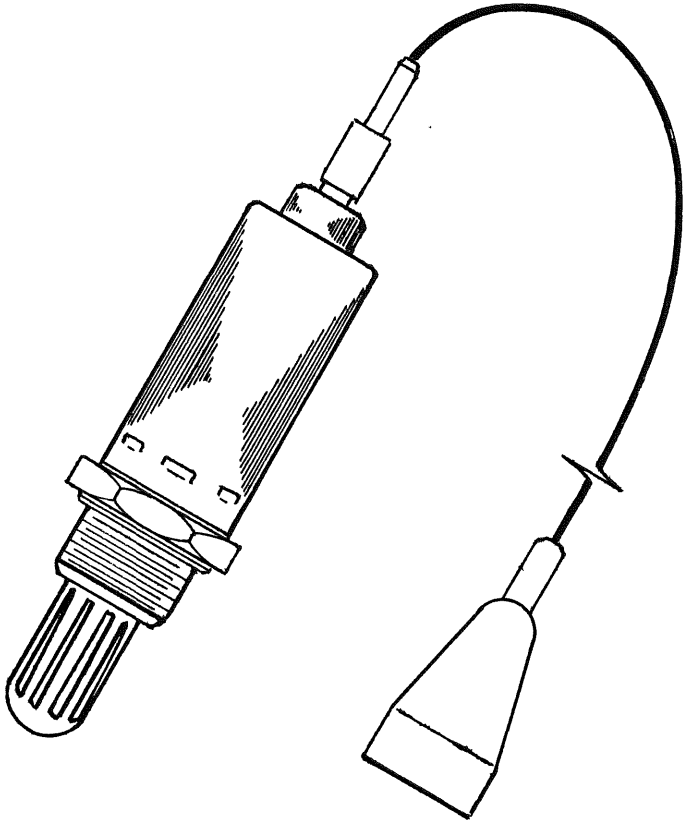
*C.C. TO LEAN
CW TO RICHEN*

1980 - 83

7b) Test your adjustment by "blipping" the throttle, that is, as quickly as possible open the throttle approximately half-way then close it just as quickly. If there is any initial "stumbling" or hesitation the mixture is too lean, so readjust the CO screw clockwise (richer mixture) and test again. Repeat this test if necessary but stay within your predetermined "boundaries".

NOTE: If your engine rhythmically oscillates at idle, refusing to maintain a relatively stable rpm (when warm), your oxygen sensor is defective (following section).



PART OXYGEN SENSOR	PRIMARY SYSTEM
ILLUSTRATION Scale - Full 	ELECTRICAL CONNECTOR Identification and color code
PART NUMBERS Oxygen sensor..... Bosch 0 258 001 010 (Lambda probe) Bosch 0 258 001 018 Superseded to Bosch 0 258 001 032	COMMENTS

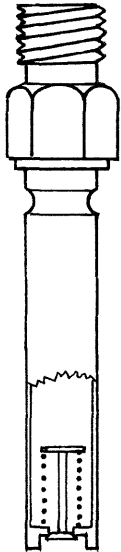
**OXYGEN SENSOR
(Lambda Probe)
Unleaded Fuel Models Only**

Superseding the belt driven smog pumps, EGR systems and thermal reactors is the catalytic converter/oxygen sensor emissions system. Located in the down-pipe just below the exhaust manifold, the oxygen sensor evaluates the exhaust gases and then relays this information (via a "brain box") to the frequency valve at the fuel distributor. The sole purpose of the oxygen sensor/brain box/frequency valve network is to guarantee a near perfect fuel mixture (14.7:1 air to fuel ratio) allowing the catalytic converter to work at its utmost efficiency.

At regular 30,000 mile intervals, your lambda light will remind you that your sensor (in accordance with factory instructions) must be replaced. Actually the oxygen sensor can last as long as 45,000 miles and regardless of what the light tells you, the behavior of the engine will indicate the exact moment the sensor fails.

When the probe finally expires, it automatically gives such a reading as to cause the fuel mixture to become too rich at idle (engine at operating temperature). This causes the idle to oscillate up and down as well as a drop in fuel economy. To verify, unplug the sensor at the connection of the green and black wires. If the idle stabilizes, your only alternative at this point is replacement.

To replace, jack the car up in front and secure it well. The probe is in plain sight on the exhaust downpipe. Using a 22mm wrench, (some companies sell a special socket), loosen and remove the probe. Now follow the thin black wire up to the connection mount where it joins with a green wire, and simply pull the connection apart. Put anti-seize compound on the threads of the new probe, and tighten enough to crush the sealing ring to avoid exhaust leaks. To finish up, run the probe wire back to the green wire and connect them.

PART FUEL INJECTOR	PRIMARY SYSTEM
ILLUSTRATION 	ELECTRICAL CONNECTOR Identification and color code
PART NUMBERS Fuel Injector... 1977-1979..... Bosch 0 437 502 015 Fuel Injector... 1980-1982..... Bosch 0 437 502 006	COMMENTS

K-JETRONIC FUEL INJECTORS

Location and Description:

At the junction of each of the four intake manifold runners and the intake ports of the cylinder head, are the fuel injectors. Each is simply a heavily spring-loaded valve that, when activated, sprays a conic pattern of fuel mist to facilitate atomization with the intake air rushing by.

Function:

K-Jetronic injectors are not electrically activated, but mechanically triggered by the pressure of the primary fuel supply, as delivered by the fuel distributor. Injectors are designed with a precise valve opening threshold of 3.3 bar (48.5 psi), and therefore have two functions. First, they must maintain any and all fuel pressures lower than 3.3 bar without a pressure drop. Secondly, they must deliver all the fuel supplied above 3.3 bar and in a fine enough spray for proper atomization. It follows then that injector failure can take two forms; (1) below threshold leakage and (2) above threshold restrictions caused by fuel deposits (see following section for detailed failure explanations).

Trouble-Shooting Leaking Injector(s):

Leaking injectors are relatively easy to identify. Keep in mind, however, that a poorly tuned engine or any engine intake leaks can cause similar poor performance symptoms. Also, even though the fuel pressure relief valve (located in the fuel distributor) rarely fails, it is a simpler procedure to test the system pressure with a pressure guage prior to the following procedure.

- 1) Start the engine and warm to operating temperature. (This is to eliminate any possible cold start problems that would interfere with pinpointing the main trouble.)
- 2) While the engine idles, loosen, one at a time, each of the four 13mm "banjo" bolts that attaches the injection lines to the fuel distributor.
- 3) Each time you loosen a fitting, fuel should seep out of the line and the idle rpm should noticeably lower. Then when you retighten the bolt, the idle should return to the previous rpm. Repeat this procedure until you have located the line(s) that has no effect on the idle rpm whether tightened or loosened. This is the one with which you want to continue trouble-shooting.

4) Completely remove the "banjo" bolt from the fuel distributor while the engine still idles. Holding the line out of your way, apply medium pressure with your thumb over the exposed hole in the fuel distributor. If you can easily stop the flow of fuel, your fuel distributor is at fault and will have to be replaced. If, however, fuel sprays out from under your thumb, in spite of your thumb's force, you have found the leaking injector that needs replacing. (1980-83 models: go to Step 2 of replacement section.)

5) An alternative method is as follows. After shutting off the engine, completely remove the bolt of the suspect line. Then remove the bolt of the line next to it and switch the lines. Tighten both bolts, making sure that each line has its two sealing washers. Now restart the engine and repeat steps #2 and #3.

6) One of two things should have happened. Either the same line still has no effect on the idle when loosened, or the line that now has no effect on the idle, was working fine before you switched them. In the first instance, you have discovered a faulty fuel distributor; in the latter, a leaking injector.

Trouble-Shooting Restricted Injectors:

Once again, be certain that the engine is in proper tune and there are no intake leaks before beginning this procedure. Also, since it is an easier procedure to run, inspect the metering pin as described in the fuel distributor section.

The symptoms of a faulty differential valve in the fuel distributor and a restricted injector (injectors very seldom totally plug off) are quite similar, with one exception. In the first instance a very rhythmic but rough idle occurs as if running on three cylinders, but in the latter, the idle will be smooth and normal. Those with a rough idle should refer to the fuel distributor section. Those with a smooth idle, read on.

Remember, your BMW is the finest diagnostic tool you could possibly own. If observed closely enough it will tell you precisely from what problem(s) it suffers. There are, then, three specific kinds of behavior your engine will manifest, corresponding to the degree of injector restriction.

I. Light Restriction (Cold Engine):

Start your engine. Without touching the throttle, check for a smooth, normal idle. With a very quick motion, rev the engine to approximately 4,000 rpm and immediately release the throttle so

42 that the engine returns to idle rpm. Repeat this three or four times, checking for quick, smooth engine response. If it hesitates, stumbles slightly, "pops" (backfires) in the intake manifold, or almost dies, try opening the throttle more gradually, checking for a smooth acceleration up to 4,000 rpm. If the engine will smoothly rev with a gradual throttling but stumbles when the throttle is quickly "snapped" open, your problem rests with the warm-up regulator and not the injectors. If, regardless of how quickly you throttle, the engine refuses to smooth out, is reluctant to climb up to 4,000 rpm and seems to even run rougher as it accelerates, you have diagnosed a mild case of injector restriction. In other words, as long as the engine is warm, the injectors for the most part deliver adequate amounts of fuel, but since a cold engine requires a richer mixture (increased volume of fuel for any given rpm) this would be the only time a slight restriction would manifest itself.

II. Mild (Medium) Restriction:

Warm the engine to operating temperature and establish the fact that you have a normal smooth idle. While in "Park" or "Neutral" rev the engine and it should respond normally as well. Now we need to test drive to differentiate between slow, or gradual acceleration and maximum or very quick throttle movement as if racing or trying to pass another vehicle.

If you have a fair amount of injector restriction your car will gradually and smoothly accelerate up to any rpm you seek (within reason), but the moment you accelerate hard it will stumble severely and will continue to run as if on three cylinders unless you relax the throttle back to a very gradual acceleration or just enough to maintain velocity at which time the engine will smooth out again. Repeat this several times to confirm your diagnosis.

III. Severe Restriction:

This condition is the easiest to trouble-shoot because of the uniqueness of the car's behavior. While test driving the car it will become very clear that your injectors are really plugged shut when your engine revs to a certain rpm (usually between 3,000 and 5,000 rpm) and refuses to rev further regardless of what you try to do. Once again, though, it is imperative that you have previously ruled out the metering pin in the fuel distributor as the probable cause, for the symptoms are identical.

Most of all, you will want to replace the faulty injectors with new ones and if yours is a severe instance or an engine with over 70,000 miles, we recommend replacement also. However, instances of light to mild restriction and low mileage, have been successfully repaired without replacing or even removing the injectors from the engine.

If you have access to compressed air (at least 80 psi), a rubber tipped air nozzle, and some carburetor cleaner (e.g. Zep, Gumout) you can save yourself some expense with the following procedure:

- 1) Remove the spark plugs to avoid fouling them.
- 2) Remove all four banjo bolts that attach the injector lines to the fuel distributor.
- 3) Using an 8mm x 1 (fine thread) nut, tighten the injector line with sealing washers onto the banjo bolt.
- 4) Repeatedly spray carburetor cleaner into the hole on the bolt and with the compressed air blow it through the lines and injectors into the cylinders. Do this approximately six to eight times per injector.
- 5) Afterwards, attach all injector lines, replace plugs and start the engine to determine how successful you have been. (Our success rate is approximately 60 - 70%, so the odds are in your favor.)
- 6) If unsuccessful, proceed to the "Injector Replacement" section.

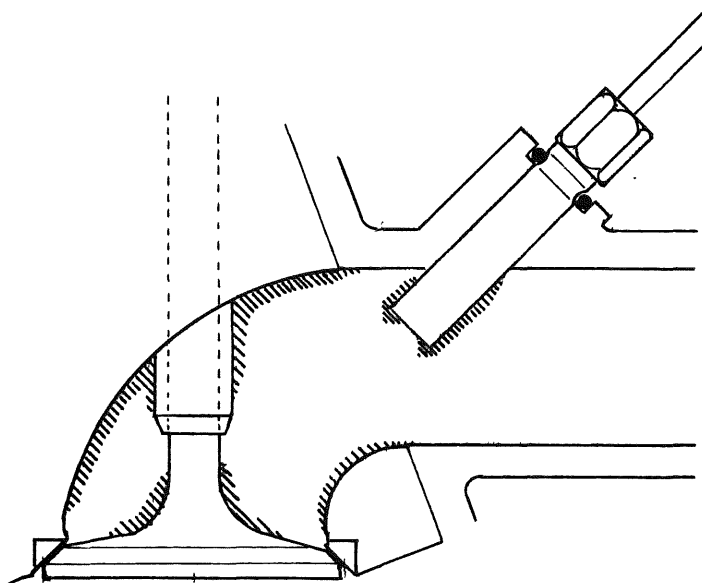
Injector Replacement:

- 1) On 1977-79 models, if the problem rests with injector #1 or #4, go to the next step. To remove injectors #2 or #3 it will be necessary to remove the intake runner corresponding to the particular injector at fault (e.g. #2 runner removed to replace #2 injector). Simply remove the four 12mm nuts and pull the runner out of the way.
- 2) The injectors are simply pressed into the head or manifold. Using a big screwdriver, slip the blade under the edge of the 14mm line fitting and pry, using the valve cover as a fulcrum, until the injector pops out of its seat. An alternative method would be to use a vise-grip on the 14mm fitting from the top and twist and pull until the injector comes free.
- 3) Being careful not to twist or bend the lines too much, remove the injector (12 & 14mm wrenches) from the line. It is possible, however unlikely, that the line itself is restricted. Blow through the line to make sure this is not the case. If it is plugged, you'll have to replace it or fabricate one (Würth sells repair kits).

- 4) Install the new injector(s) with a new O-ring seal, apply a little grease to the seal and insert into its seat as far as possible by hand. Armed with a screwdriver and a small mallet, place the blade end of the screwdriver on top of the 14mm line fitting and tap the injector down into the hole until properly seated.
- 5) All that remains for early models (1977-79) is to attach the intake runners, taking care that each mating surface is free of all debris except an intact gasket.
- 6) All models; reconnect the injection line(s) at the fuel distributor. Make sure there is a copper sealing washer on top and on bottom of each banjo fitting.

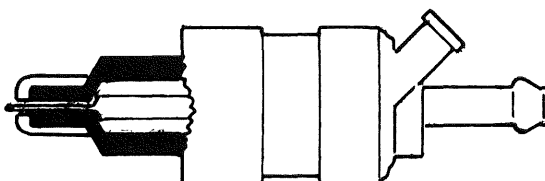
Why L-Jetronic Injectors Do Not Fail:

If you ever pull the valves out of a cylinder head you will notice that the intake port and valve will have a heavy deposit of soft carbon. Looking at the valve seat and valve face you will notice that both surfaces are free of carbon. The constant opening and closing of the valve against the seat causes the two surfaces to stay clean.



▨ = carbon deposits

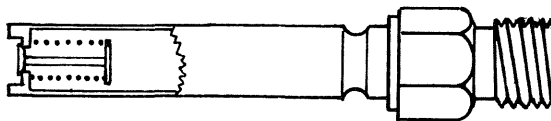
L-Jetronic injectors open and close electromagnetically, triggered by the ignition points. This opening and closing action of the injector needle against its seat causes the needle and seat to remain carbon free.

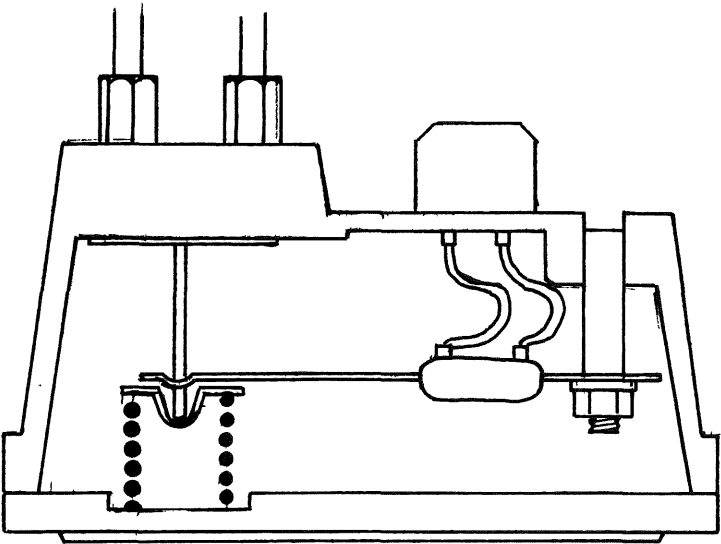
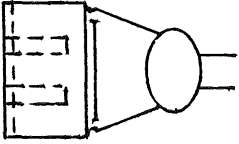


Why K-Jetronic Injectors Fail:

Now, for the sake of argument, imagine what would happen if the intake valve remained open, constantly. Carbon would soon collect on the valve seat and valve face. Causing the port to plug and the valve and seat not to mate perfectly.

K-Jetronic injectors open when the fuel line pressure exceeds 3.5 bars (50 psi). Since the operating pressure of this system is about 5 bars, the fuel injectors are open constantly. This results in an accumulation of carbon between the needle and the seat. That restricts fuel flow. Fuel restriction becomes apparent during high fuel demands; such as cold engine operation and high rpm acceleration. Carbon on the needle and seat can also cause the injector to leak when the deposits prevent the needle from seating.



PART WARM-UP REGULATOR	COLD START
ILLUSTRATION 	ELECTRICAL CONNECTOR Identification and color code  GRAY
PART NUMBERS Warm-up regulator... 1977 - 1979 Bosch 0 438 140 014 1980 - 1983 Bosch 0 438 140 071	COMMENTS Warm-up regulators lean out as the car ages but they can be recalibrated.
SPECIFICATIONS The resistance measured between the warm-up regulator's electrical terminals should measure apx. 18 ohms	

WARM-UP REGULATOR

Location and Description:

On all models of 320i's through the 1983 model year, the warm-up regulator is bolted to the engine block directly below the starter. Basically, it is a hollow rectangular aluminum box with two plastic fuel lines connected to one side of the top, and an electronic fuel injection plug-in on the opposite side.

Function:

By virtue of these two fuel lines (one inlet and one outlet) the regulator's sole responsibility is to lower the control (secondary) fuel pressure, which inversely increases the primary fuel pressure, when the engine is judged "cold" (as determined by the temperature guage). For the first few minutes of a "cold" engine warm-up cycle, control fuel bleeds through an extremely small orifice in the top of the regulator. The precise quantity of fuel is controlled by a spring loaded pin that presses on two thin steel diaphragms that cover this orifice. The pressure of the pin, at any given moment during the warm-up cycle, variably restricts the fuel flow through this orifice, ranging from no restriction (an extremely cold engine) to completely sealed ("warm" engine temperature).

The position of the spring-loaded pin is determined by a bi-metallic strip (two strips of metal with significantly different thermal expansion rates, bonded together to act as one) with a resistor mounted around it, which in turn is wired to the electronic plug-in terminal on top of the housing. The instant the ignition switch is turned to the "on" position, current is fed to the resistor and it quickly begins to warm. As the resistor's heat conduct to the bi-metallic strip, it begins to expand. Since, by design, the bottom of this strip expands faster than the top, the strip begins to bend upward. This upward movement allows the spring to apply increasingly greater pressure on the pin, and likewise the two steel diaphragms, which very gradually restricts the orifice until it is finally completely closed.

As you can see, the warm-up regulator primarily works like an electric choke on a carburetor, in that both are timed to function correctly via electrical current instead of sensing the fuel mixture needs of the engine thermally. The regulator is mounted to the engine block, however, for one specific starting condition. If you restart your engine within approximately 30 minutes after previously running at operating temperature, there is no need for a richened fuel mixture. So, to avoid the possibility of the bi-metallic strip cooling off faster than the needs of the engine would dictate, the regulator is in close enough proximity to assure that the orifice remains closed until the engine itself is sufficiently cooled.

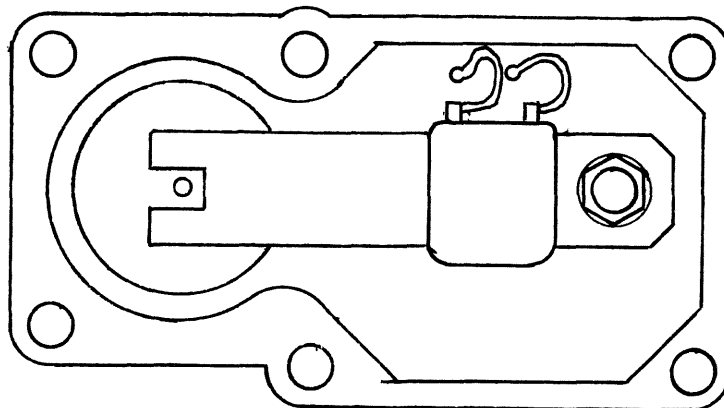
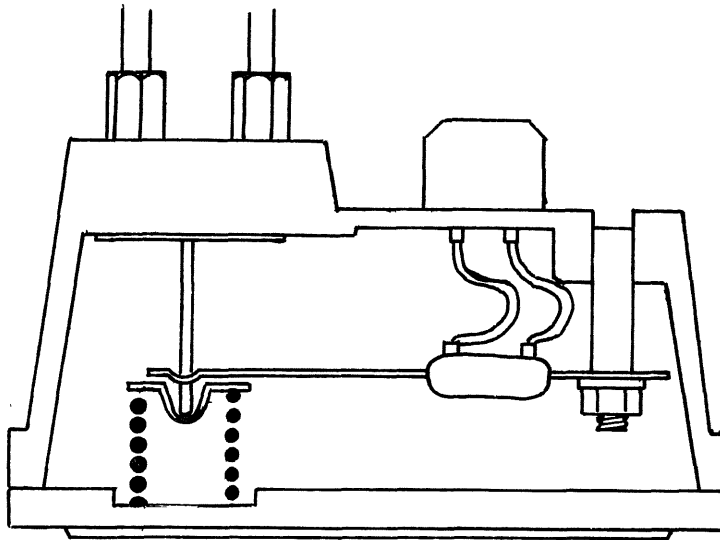
Any failure of the warm-up regulator to accurately satisfy a "cold" engine's demands for a richer fuel mixture, therefore, becomes a question of synchronization. Over a period of time (usually beginning around 40,000 miles) the engine's normal aging process will result in what appears to be a gradual leaning of the fuel injection system. Engine parameters become more unstable and one of the very first indications will be the cold start problem of too lean a fuel mixture for acceptable cold-engine performance, i.e. hesitant throttle response, lower than normal idle and eventually refusal to operate entirely. The following procedures outline the necessary steps to re-synchronize your warm-up regulator to coincide with cold engine running requirements. This is accomplished by precisely repositioning the spring loaded pin that governs the restricting of the control fuel orifice. As a reminder, the engine must run properly while "warm" before attempting warm-up regulator recalibration.

Repositioning for Adjustments:

Before adjusting, we first need to maneuver the warm-up regulator into a servicing position without separating it from the fuel system.

- 1) Using a T-handled hex wrench or allen key (5mm), locate and remove the two hex head bolts that attach the regulator to the block.
- 2) Pull the regulator out away from the block enough to remove the plug-in terminal. To avoid breaking the tabs on the plug, use a small screwdriver or pick to pry each side of the wire retainer out far enough to clear the tabs, allowing the plug to easily slip off.
- 3a) 1977-79 Models: Now, with the fuel lines still attached, gingerly maneuver the regulator up through the space between the bundle of fuel injector lines and the firewall to an upright position near the driver's side shock tower. Avoid excessive twisting and bending of the attached lines.
- 3b) 1980-83 Models: Trace the fuel lines from the regulator to the fuel distributor; one bolts to the lower side and the other attaches to the middle-top. Disconnect both lines, and make a special note of the two copper sealing rings and where they are placed. Coax the regulator and its intertwined lines up and out of the engine area. When cleared, position the regulator on top of the intake manifold while you reattach both fuel lines to the fuel distributor, in their respective locations (don't forget the sealing rings).

4) All Models: From the underside of the warm-up regulator, remove the four screws and nuts that join the two housing sections. Holding the regulator upside down (both fuel lines are still attached), pry the bottom loose and gently remove it. Look for a spring, a steel pin and a metal "cup" that cradles the pin, to be loose inside. Remove these three items and set them aside. (If the inside shows evidence of any corrosion deposits, the regulator will have to be replaced.)



5) Above the fuel line fittings (from your point of view) is a hardened circular disc held by four screws with another smaller cup in the middle. Directly below this cup is a fuel orifice surrounded by an O-ring. It is the restricting of this orifice, by applying variable pressure on the center cup, that determines the "richness" of the primary fuel delivery.

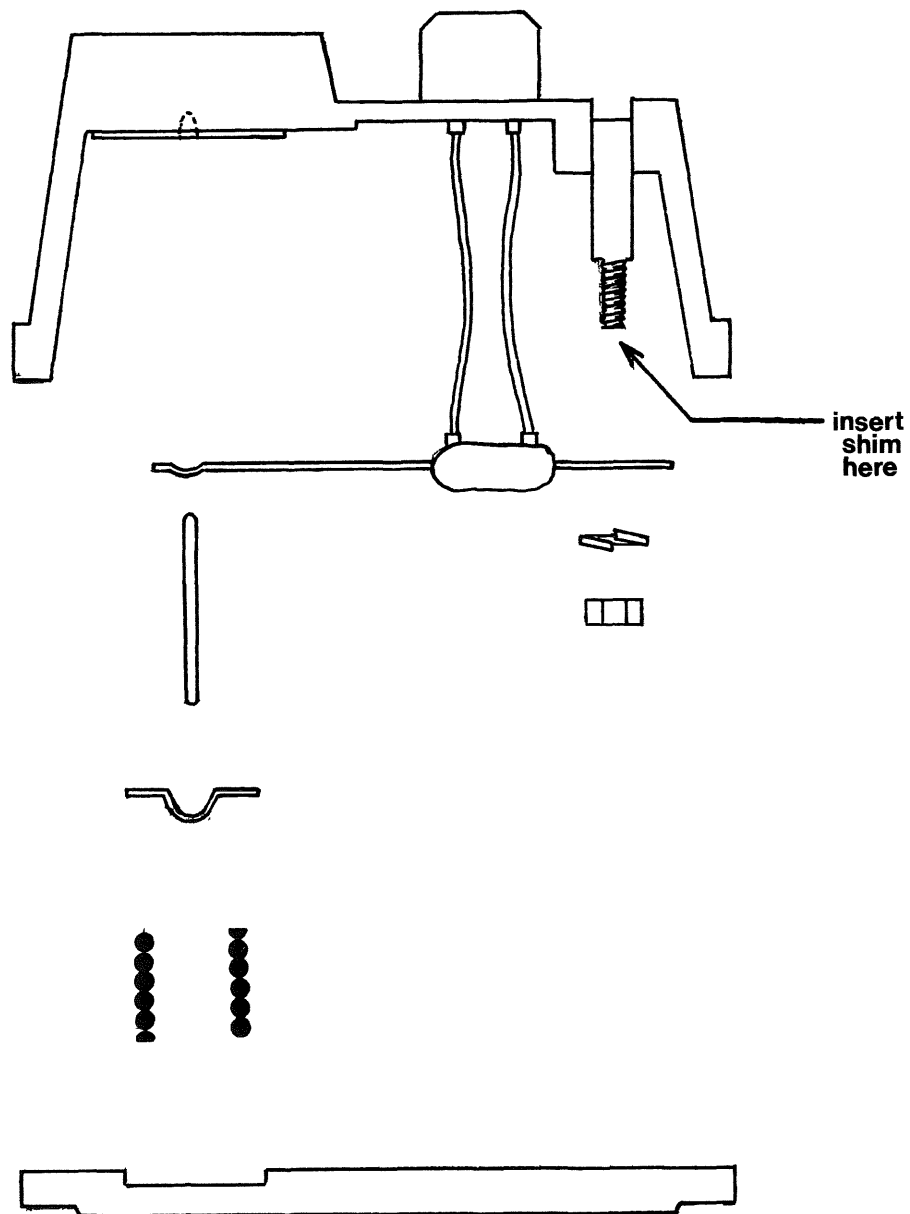
6) This variable pressure is controlled by the bi-metallic strip that is mounted to the pressed-in shaft at one end and suspended over the center cup at the other. Since the spring force, pin length, and bi-metallic strip expansion rates are necessary constants, the height of the strip mounting point (the distance between this point and the top of the regulator) will be the place for adjustments.

7) Loosen and remove the 10mm nut, lock washer and flat washer that anchor the bi-metallic strip to the shaft. Without breaking the electrical connections, slip the strip off the threaded part of the shaft. Note exactly how many washers, if any, are still left on the threaded shaft (it is imperative that they remain there) and thread the nut back on to retain them.

8) Now you will need two strips of feeler guage material and a paper hole punch. One strip needs to be .002" stock and the other .003" stock. Measure the width of the strips and measure four of these lengths. Either by folding or with some kind of cutters, snip off these four squares. Be sure and mark one group of squares to enable you to distinguish between the .002" and .003" ones. Lastly, punch holes in the center of all eight squares. A hand-held paper punch will cut steel up to .005".

9) Symptoms of an out-of-adjustment regulator will range from very slight hesitation when "blipping" the throttle, to the engine dying when trying to accelerate. The more severe the hesitation, the greater the amount of shimming will be necessary for correction. Since most adjustments fall within the .006" to .012" range, we suggest starting with .008" first.

10) Remove the 10mm nut and in addition to whatever washers are already there, add two .003" shims and one .002" shim. Remount the bi-metallic strip, flat washer, lock washer and nut, then tighten firmly. Make sure that the slot in the opposite end of the strip centers over the small cup on the hardened steel disc.



11) Replace the pin (into the small cup), the large spring cup and the spring in the same position from which they were removed.

12) Making sure that the spring rests in the circular indentation in the bottom housing, position it onto the upper housing and fasten them with the four screws and nuts.

13) It will not be necessary to make the electrical connection or to remount the regulator to test your adjustment. For an accurate reading, however, you only have five or ten seconds of running time for testing (the warmer the ambient air temperature, the more critical this testing time becomes). Unplug the vacuum retard line from the distributor and leave disconnected until all adjustments are concluded.

14) The test procedure is as follows: start the engine and as quickly as the idle rpm stabilizes, "blip" the throttle once or twice to determine the immediacy and smoothness of the engine's response, i.e. the absence of any hesitation or roughness.

15) Regardless of the severity of your cold start symptoms, you should observe either (1) no change in the engine's behavior or (2) distinct symptomatic variations.

a) No change in symptoms, assuming that there were no procedural mistakes, indicates that corrections were made to the wrong fuel injection component. Refer to the troubleshooting charts again to verify your diagnosis. Oftentimes, slightly restricted or leaking injectors will cause similar symptoms. regardless of the situation, it will be necessary to disassemble the regulator, remove the added shims, reassemble the regulator and remount it to the block.

b) If the severity of hesitation is less, but not totally alleviated, you are on the right track. Return to step 5, adding additional shims until your test results are correct or until additional shimming has no effect on the engine's starting and idling behavior. Remember, the more tests made, the more cautious you will have to be of warming the engine. THE ENGINE HAS TO BE STONE-COLD TO GIVE ACCURATE RESULTS!

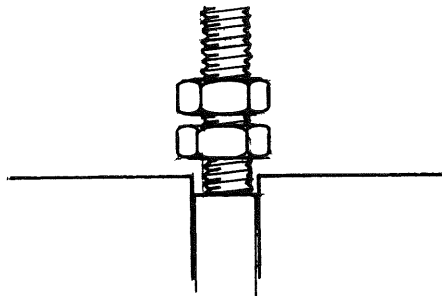
c) If your test results indicate a lower idle rpm than the previous and/or a "loaded-up", slow responding throttle (as if the timing is retarded) coupled with extremely rich smelling exhaust, some shims will need to be removed (return to step 5). It is possible that a .002" or .003" shim will be sufficient.

16) By this point your cold engine running behavior should be smooth and free revving, with possibly one exception. The cold engine idle rpm on 1979 320i's will remain at or only slightly above that of a warm engine, through the entire warm-up cycle. If your's is not such a model, but has this problem, refer to the auxiliary air valve section for a cold engine idle adjustment (remember to plug-in the vacuum retard line to the distributor when you have concluded).

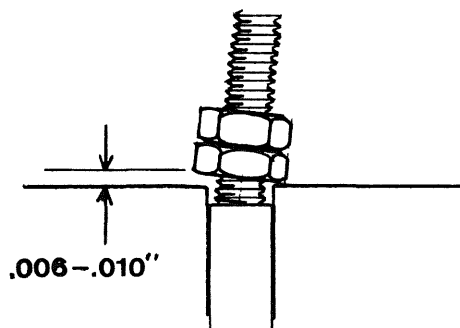
Alternative Recalibration Method

Looking at the top of the regulator, along the two fuel lines and electrical connection, you will notice a circular indentation 10mm in diameter. What you are seeing is the top end of a pressed-in steel pin that locates the spring loaded bi-metallic strip. This strip controls the pressure on the diaphragms which regulate fuel flow by variably restricting an orifice. Using a set of callipers, on end, measure the depth of the pin with respect to the top of the regulator (readings will vary between .075" and 1.025" usually). Our objective now is to "lower" the shaft or increase this depth by approximately .005" increments, by using the following procedure:

- 1) Take a 3" to 4" long bolt (8mm), thread two nuts on it then stand it upright in the hole into which the shaft is pressed.



- 2) Thread the bottom nut down until it bottoms on the surface of the regulator, then counter-clockwise 1/6 of a turn. Thread the top nut down to meet the bottom one to hold its position.
- 3) Now tilt the bolt until the bottom edge of the lower nut touches the regulator surface. Holding this position, use your feeler gauge to measure the air gap between the bottom nut and the surface, 180° from the resulting point of contact.



- 4) Continue to lower and lock together both nuts until you have obtained a measured gap of .006" to .010".

CAUTION: Be advised that several minute adjustments are preferable to those that move the shaft too far.

- 5) With a block of wood under the warm-up regulator for dampening and a good size hammer, locate in a good hitting position (pre 1980 models - against the shock tower; 1980-83 on top of the intake manifold).

- 6) Hold the bolt directly over the locating pin hole, as perpendicular as possible, and give the bolt head a firm hit with the hammer, as if driving a nail into a block of wood. You will need to hit it hard enough so that the bottom nuts end up seated on the regulator housing.

- 7) With the regulator still off the engine and electrically unplugged, use the callipers again to determine how far you moved the pin. If the difference in your measurements is less than .003", you need to repeat steps 1-6. If you moved the pin more than .008" you might have to disassemble and reposition the shaft, depending on the behavior of the engine.

Remember, if the engine is allowed to run long enough to warm, no further warm-up regulator adjustments can be made until it is completely cold again. Also, the warmer the outside temperature, the shorter the cold start cycle. Therefore you will only have approximately five to ten seconds to determine the results of your adjustment(s). The test procedure is as follows:

Without touching the throttle, start the engine and check for (1) at what rpm it idles and (2) how smooth and steady the idle is. As soon as you've determined this, quickly "blip" the throttle once or twice to test for any hesitation or "stumbling" during quick acceleration.

If the throttle response is immediate and smooth, you've correctly adjusted the warm-up regulator and can now remount it on the engine block.

If on the other hand, the throttle response is good but the idle is low (1000 or lower) you need not adjust the regulator any further, but you will need to refer to the auxiliary air valve section for a cold-engine idle adjustment.

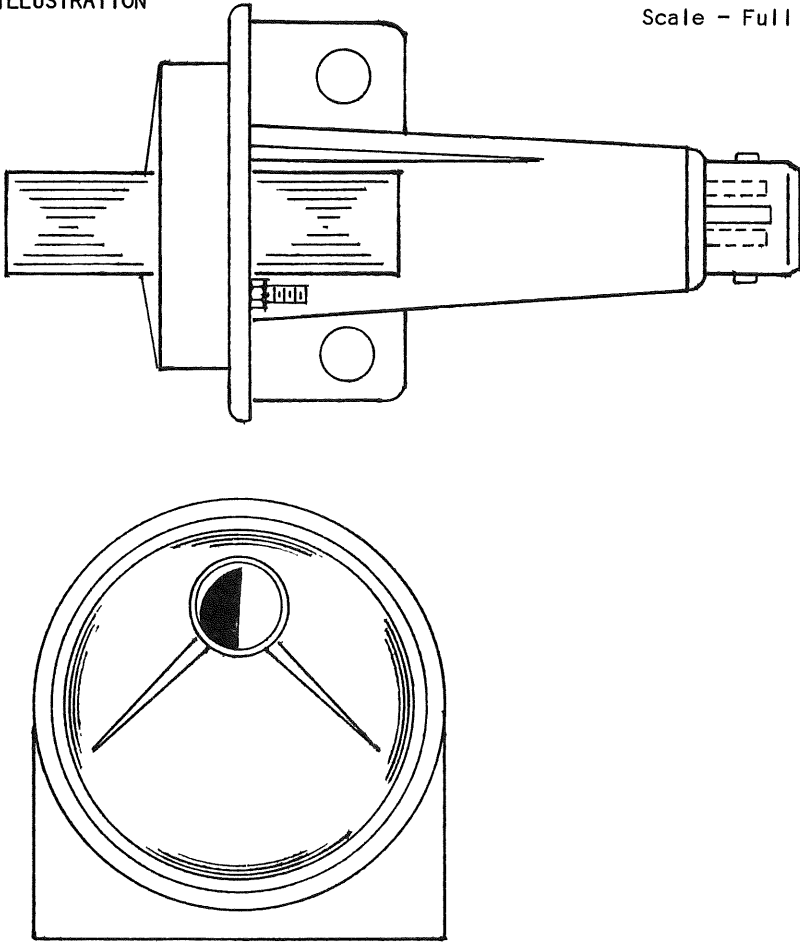
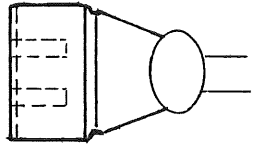
If the throttle response is better but not completely free of hesitation or stumbling, repeat the adjusting procedure. It can take as little as .003" and as much as .015" to correctly adjust the warm-up regulator. If there is absolutely no change in the engine's behavior and you are certain of at least a .005" movement of the shaft, the cause of your fuel injection problems are to be found elsewhere, and most probably concerning the fuel injectors.

Finally, if the idle drops low (500 to 800 rpm) and throttle response is not hesitant but "loaded-up" or as if the timing is retarded, coupled with a very rich exhaust, you have lowered the pin too far and must now disassemble the warm-up regulator to position the pin in its original position.

- 1) Disconnect both of the fuel lines on the regulator and remove the four housing bolts and nuts.
- 2) Holding the regulator upside down, pry the bottom off, taking note of the spring, metal cup and small pin balancing on one end of the bi-metallic strip.
- 3) Carefully remove these three loose items and place a 10mm socket on the 10mm nut where the bi-metallic strip bolts to the locating shaft.
- 4) With the aid of a bench vise or press, reposition the pin to the original depth, or at least to a position you know to be lean enough that you can begin adjusting form once again. Don't be discouraged. This is a very difficult recalibration to make and it could take several attempts before the engine will run correctly.

58 Refitting:

On models through 1979, carefully work the warm-up regulator back down close to its mounting position. Once again, avoid "kinking" or twisting the fuel lines. Before bolting to the block, reattach the push-on terminal noting that it only goes on one way. Now place the top mount bolt in the hole in the regulator and start it into the block. Before tightening, start the bottom bolt and tighten it, then tighten the top mounting bolt and you're finished.

PART AUXILIARY AIR VALVE	COLD START
ILLUSTRATION Scale - Full 	ELECTRICAL CONNECTOR Identification and color code  BLACK
PART NUMBERS Auxiliary air valve... 1977 - 1979 Bosch 0 280 140 104 1980 - on Bosch 0 280 140 126	COMMENTS Auxiliary air valves used on 320i's are adjustable.
SPECIFICATIONS The resistance measured between the auxiliary air valve's electrical terminals should measure apx. 20 ohms.	

Location:

On early 320i's the auxiliary air valve is mounted on the valve cover directly above the #4 intake valve rocker arm. The late 320i's (1980-83) location is on the intake manifold side of the cylinder head.

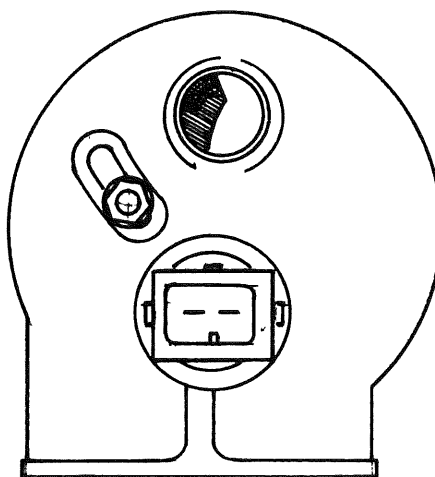
Function:

In order for the engine to idle by itself (i.e. with the throttle closed) it is necessary to allow a certain amount of air to bypass the throttle and this idle air is governed by the idle air bypass screw. When the ambient air temperature drops below 68°F, the fuel mixture must be richened to provide adequate vaporization for combustion. However, to maintain a smooth and consistent idle, additional air must bypass the throttle valve. Augmenting the volume of idle air, during "cold" engine conditions, is the responsibility of the auxiliary air valve.

Symptoms/Adjustments:**I. Low Rpm Idle (Cold Engine)**

Engine idle at operating temperature should be at or near 1000 rpm (if not, refer to "CO/fuel mixture" section). At temperatures below 68°F, a "cold" engine will initially idle between 1200 and 1400 rpm, and after approximately two minutes the rpm will abruptly fall to between 900 and 1100, until the temperature guage nears the halfway mark, at which time the tachometer should consistently read 1000 rpm. If the cold engine idle is always at or below 1000 rpm (warm engine idle rpm) during all cold-start conditions and yet the engine revs with immediate response, without hesitation, your auxiliary air valve is not opening enough to allow sufficient bypass air for a stronger, higher rpm idle. To determine whether or not the valve functions:

- 1) Loosen the 7mm nut on the front (1977-79) or top (1980-83) side of the large center disc to which both hoses clamp.
- 2) Using the long tubular part of the housing as a fulcrum and a medium screwdriver as a lever, pry the nut towards the outside of the disc.



3) Start the car (engine must be "cold") and immediately turn it off when the initial idle rpm reading has been made. It should be higher than it was prior to adjusting the valve.

4) If the rpm is too high (over 1400) start the engine, move the nut back towards its original position until the rpm is correct and retighten.

5) If there is no change in rpm or the nut is already adjusted out to its limit, slide it back towards the center of the disc until it stops. Restart the engine with the expectation of observing an even lower idle rpm than was observed, prior to adjusting.

6) If the idle is indeed lower, quickly reset the idle bypass screw (on the side of the throttle housing) then shut off the engine to cool. Return to step 2 and repeat the necessary procedures.

7) if there is no change in idle rpm regardless of the location of the adjusting nut, the valve will have to be replaced.

II. High Rpm Idle (Warm Engine)

There are several possible reasons why an engine refuses to idle down to its normal operating temperature rpm:

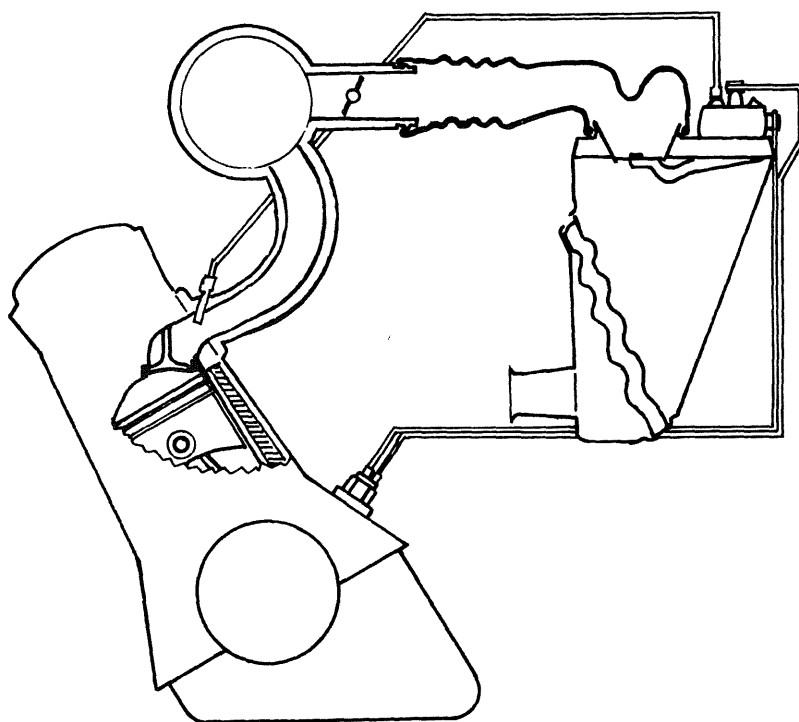
- a) Loosen the air hose from the valve at the end that attached to the intake manifold (directly under the cold start injector).
 - b) With the engine idling, in one swift motion remove the hose and block the inlet on the intake manifold completely with one thumb, while testing the air hose for suction with the other.
 - c) If there is noticeable suction and the engine is at operating temperature, the auxiliary air valve is defective.
 - d) If there is a slight amount of suction, loosen the 7mm nut on the valve and sliding it towards the tubular part of the housing. It might be possible to close the valve sufficiently to eliminate the unwanted air flow. If not, it will need to be replaced.
- 2) Bolted to the air flow housing next to the fuel distributor are two large metal discs (about 3" in diameter) connected to each other, the intake boot and the intake manifold. This is the deceleration valve. The sole purpose of this apparatus is to promote a better fuel "burn-off" when quickly decelerating, by forcing the engine to gradually return to idle rpm. Oftentimes it will give warnings of impending failure by "hanging-up" the idle for a few seconds before allowing it to return to normal. Since it is not adjustable, to disarm it you need only block the smaller of the two vacuum lines from the intake manifold with a steel ball or dowel pin.
- 3) Throttle sticking - there are two return springs attached to the throttle mechanism that occasionally lodge in their plastic sheaths. The easiest remedy is to remove the sheaths. If you want to maintain "factory" appearances, replace the springs with smaller diameter ones with comparable tension.

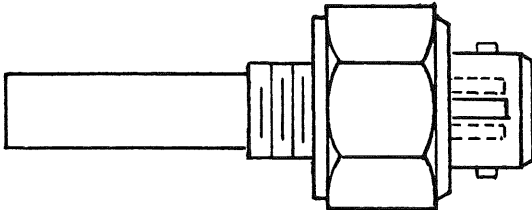
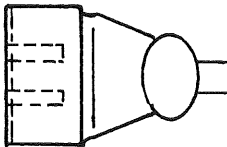
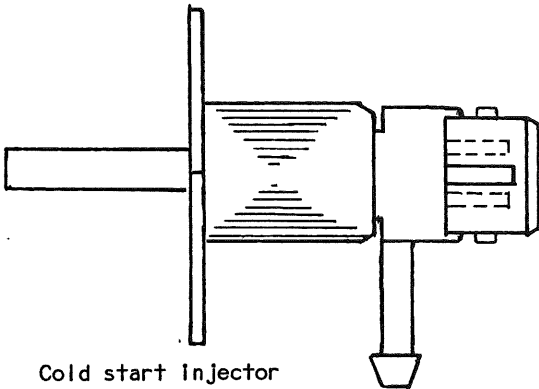
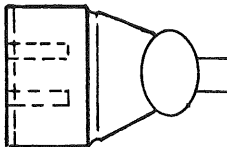
Occasionally the throttle shaft itself will become stiff enough that it will not totally return to idle position. Any spray lubricant (e.g. WD-40, ZEP-45) will free the mechanism.

4) All models of 320i (1977-83) are equipped with distributors with a vacuum retard diaphragm. The vacuum retard is always on at idle, and without it a good part of the total advance in the distributor is lost. The plumbing includes a vacuum line from the throttle body to a small black disc mounted on the intake manifold (notice the electrical plug-in) called a thermal valve. Another vacuum line runs from this valve to the vacuum retard diaphragm. There has to be vacuum present for the vacuum retard to function, so by simply warming the engine and disconnecting the vacuum line on the distributor, you can discover if it is indeed in operation. The engine should idle approximately 400 to 600 rpm higher, and will idle down as soon as the line is reconnected. If this does not happen, you have a vacuum leak somewhere between the throttle body and the vacuum diaphragm. a more probable cause would be the small black thermal valve.

Every time the engine is started (unless already warm) this valve is closed, blocking the vacuum from the diaphragm. This accounts for a higher idle for smoother cold engine running. After only a few minutes (exact time governed by ambient temperature) via the electrical circuitry, it opens allowing the vacuum retard to activate, which in turn, lowers the idle. If, when you remove the vacuum line leading to the diaphragm, there is no increase in idle rpm and there is evidence of vacuum in the other vacuum line connected to the valve (you can feel and/or hear the suction), the thermal valve will need to be replaced.

5) If a high warm engine idle still persists, refer to the section on "intake leaks".



PART THERMO-TIME SWITCH and COLD START INJECTOR		COLD START
ILLUSTRATION Scale - Full  Thermo-time Switch	ELECTRICAL CONNECTOR Identification and color code  BROWN	
ILLUSTRATION Scale - Full  Cold start Injector	 BLUE	
PART NUMBERS Thermo-time switch..... Bosch 0 280 130 214 0 280 130 219 Cold start Injector..... Bosch 0 280 170 405 1980-1983 Bosch 0 280 170 410		COMMENTS
SPECIFICATIONS Thermo-time switch operating time in seconds vs temperature. 8 seconds -4°F (-20°C) 0 seconds 59°F (45°C)		

THERMO-TIME SWITCH AND COLD START INJECTOR

Centrally located atop the intake manifold is a small blue projection with both a fuel line and an electrical terminal attached to it, called the cold start injector. Mounted on the coolant-junction housing (the part of the engine to which the upper radiator hose is attached) is an oversized temperature sensor/switch, with a two-wire electronic terminal. When cranking the engine this sensor evaluates the coolant temperature and, depending on how much below 50°F the coolant is, allows from 0 to 8 seconds of current to pass to the cold start injector. The current in turn activates the solenoid that opens the injector allowing pressurized fuel to enter the intake manifold. The colder the engine, the more crucial this initial charge of fuel. Therefore, these two mechanisms, if either malfunctions, cause difficult cold starting.

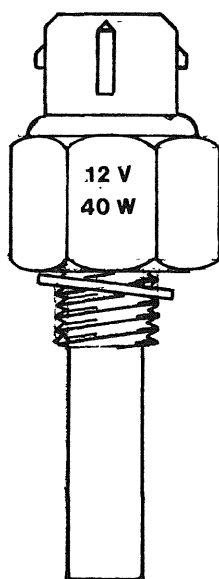
Trouble-Shooting (Cold Engine Only):

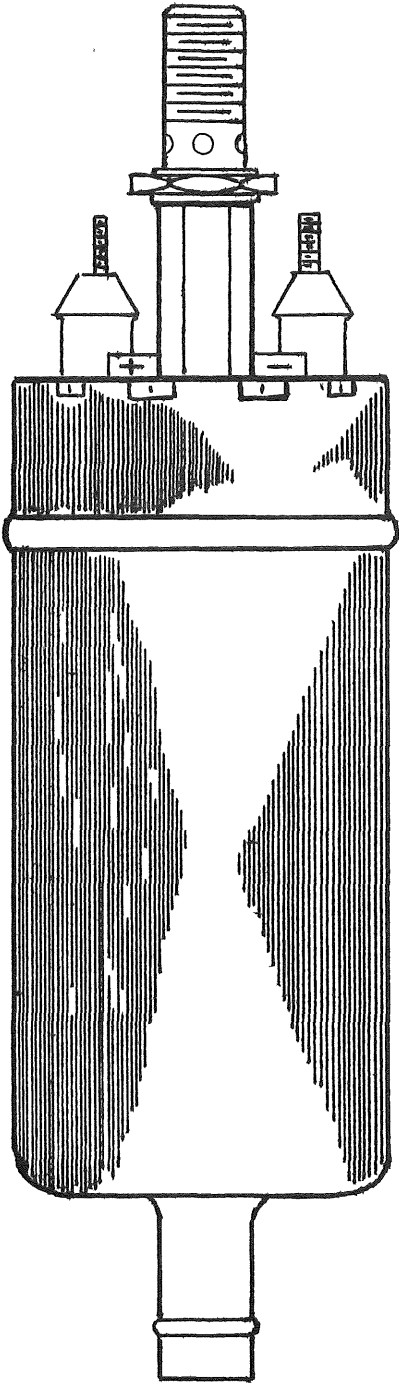
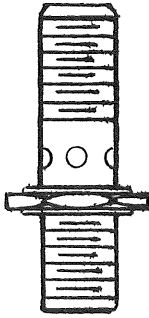
- 1) Before starting the engine, loosen the two 10mm nuts and remove the cold start injector with the fuel line and electronic connection in tact.
- 2) Find a suitable container to aim the injector into so that, when activated, fuel does not spray where it might ignite. Detach the primary lead from the coil to prevent the engine from starting.
- 3) Turn the key to the cranking position just long enough to verify that there is a conic spray of fuel from the injector, and then turn the ignition off. The spray of fuel should be simultaneous with the cranking of the starter. If this results, your cold start problem lies elsewhere. If there is no spray of fuel, continue.
- 4) Before any further electrical tests, detach the fuel line to the cold start injector (note the two sealing washers on 320i's), aim it into the container and then activate the starter. There should be a steady flow of fuel from the line. If not, refer to the section on "Fuel Pump, Relay and Fuse Trouble-shooting". If there is fuel flow, continue with the procedure.
- 5) Disconnect the plug-in terminal of the cold start valve and set up your test light with the probe on one of the two plug terminals. Activate the starter, testing for current first on one wire and then the other. One of the terminals should have current when the starter is engaged.

If so, the cold start injector needs replacing. If there is no current at either terminal, continue.

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6) Disconnect the plug-in terminal of the thermo-time switch and test both terminals for current as in step 5. If there is current at either terminal while the starter is engaged, the thermo-time switch is defective. If not, check terminal "50" (the smallest of the three on the starter) with the test light for current while the starter is engaged and to ensure that the attached wire is making good contact (see injection wiring diagram).



PART FUEL PUMP and CHECK VALVE	FUEL SUPPLY
ILLUSTRATION 	Scale - Full BMW 320i 1980 - 1983  BMW 320i 3/1978 - 1979  ELECTRICAL CONNECTOR Identification and color code
	PART NUMBERS Fuel pump... 1977-1979 Bosch GFP 215 Check valve..... Bosch 1 587 410 901 Fuel pump... 1980-1983 Bosch GFP 204 Check valve..... Bosch 1 583 386 016 COMMENTS Fuel pump check valves are replaceable on 320i after 3/19 78

FUEL PUMP, RELAY and FUSE TROUBLE-SHOOTING

Anytime your engine refuses to start and run, whether the engine is warm or cold, it more than likely involves the fuse, relay or fuel pump itself. If you are satisfied that the points are functioning, there is good spark at the plugs and that the plugs are not fouled or worn-out, run the following test procedures:

Fuel Pump Fuse:

The most common cause of fuel pump failure is its fuse. The fuse box is located on top of the left front fender next to the battery and air flow housing. On 1977 and 1978 models the pump fuse is on the same circuit as several other accessories (fuse #14), as listed on the plastic fuse box cover. All these accessories on one 16 amp circuit causes the fuse to blow once and a while. In 1979 the fuel pump was given its own circuit with the new fuse location next to the two fog light fuses on the bottom row (fuse #3). If there is distortion, corrosion or a break in the fuse's metal strip, replace it with a blue, 25 amp fuse (the circuit can accommodate it and there will be less chance of blowing). Whether you replace it or not, use your test light to make sure current is passing through the fuse (with the ignition on).

Fuel Pump Relay:

Underneath the clear plastic cover the relay is mounted on a remote plug-in connector on the passenger side of the fuse box itself. It is the tallest relay used, is black in color and has four terminals. When removed, you will note that each terminal on the remote plug-in connector is numbered (see diagram). Before testing, make a three to four inch jump wire with male terminals on each end and plug one end in slot "15" and the other in "87". Turn the ignition switch to the on position. You should hear the whine of the fuel pump(s) coming from behind and below the rear seat. If you hear nothing, leave the ignition on and with our test light check for current on both sides of the jump-wire and fuse again. If there is no current at either place you have electrical problems at the ignition switch or the power source for the fuse box. If there is current at the "87" terminal and you do not hear the pump(s) operating, continue with the next section. Finally, if you do hear the pump motor(s) running, the engine should now start and run, but refer to the trouble-shooting chart if it still refuses to do so. If by using the jump wire the engine now starts and runs, don't replace the fuel pump relay without first double-checking the points, for they also complete the circuit for the relay.

Fuel Pump(s):

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The electric fuel pump and filter are located above and to the passenger side of the differential underneath the car. Continuing with the procedure above, with the jump wire bypassing the relay and the ignition on, use your test light to verify a closed circuit. Remove the protective boots from the two terminals on the pump and using the negative post (with 8mm nut) on the pump as your ground, test the positive one (with 7mm nut) for current. If your test light shows current but the pump is not running, the fuel pump is defective, which occurs frequently in cars with more than 75,000 miles. If there is no current, your trouble has to do with the wiring of the pump circuit (see K-Jetronic wiring diagram).

On 1977 and 1978 320i's, you might have two similar fuel pumps mounted side by side, as a result of a factory recall. This being the case, you will have to test both pumps, as both must be operable for the system to function properly. From 1979 through 1983 a "pre-pump" is an integral part of the fuel pick-up underneath the rear seat inside the passenger side gas tank. You should be able to hear it operate with the jumper wire and ignition on. If not, you will have to remove the seat and lift the sending unit out of the tank in order to hear it and/or test the circuitry.

Fuel Pump Check Valve:

By far the most predictable malfunction of the fuel supply system is the failure of the fuel pump check valve. This valve (attached to the output side of the pump) is responsible for maintaining partial system pressure for a warm engine for approximately 30 minutes after it is shut off. If this valve fails to do so and you attempt to restart the engine from 10 to 30 minutes after running, it will be necessary to crank for several seconds (15 to 30 seconds). Even though once restarted the engine idles and revs normally, you still have a defective check valve.

The reason the engine has to be warm to accurately diagnose this problem is that once the engine has cooled the warm-up regulator comes into play, lowering the control fuel pressure (or equalizing pressure), which in turn increases the primary system pressure to allow for a richer fuel mixture to compensate for lack of adequate pressure. However, an extremely worn-out check valve will sometimes cause a brief amount of initial stumbling, (3 to 5 seconds after starting) even when the engine is cold .

All models from 1978-83 have replaceable check valves that are obtainable through a Bosch distributor. This will save your buying a new fuel pump just to replace an inexpensive valve. Unfortunately, 1977 owners have no choice, since the valve is an integral part of the fuel pump itself.

Vapor lock occurs when the gas in a fuel line changes from a liquid to a vapor. When this happens a vapor pocket is formed and fuel becomes blocked. Usually, vapor locking is not a problem until temperatures hit about 100°F (38°C) or more.

Symptoms of Vapor Lock:

The car will run fine for a distance and then the engine will start to cut out (fuel starvation) and loose power. If you come to a stop, the car may stall. After letting the car sit for 10-20 minutes, it will start up and run normally again. This time after driving a shorter distance the car will start another similar episode. The reason for this is simple; each time you shut off the car the fuel cools off and the gas vapor returns to a liquid state.

Eliminating Vapor Lock:

In order to eliminate vapor lock the fuel must be cooled. Fuel picks up heat from one of the following:

- 1) High under-the-hood temperatures created by the engine and air conditioning.
- 2) The gas tank absorbs heat from the hot pavement.
- 3) Fuel is heated by the electric fuel pump.

In an emergency, the simplest remedy is to allow the heat to escape out of the gas tank by removing the gas cap. On cars that use unleaded gas, you will also need to prop open the fuel restrictor flap with a screw driver. If the tank is over half-full, be cautious of spillage while driving.

If there are only a few days of the year when the temperature exceeds 100°F (38°C), try one or more of the following:

- 1) Wrap the fuel lines in the engine compartment with aluminum foil. This will reflect the heat off the fuel lines.
- 2) Paint the bottom of the gas tank silver or white.
- 3) Change fuel pumps. The fuel pump could be weak or have high internal resistance.
- 4) Integrate a fuel cooler (e.g. a small automatic transmission cooler).
- 5) The fuel return line location needs to be moved to the driver's side fuel tank because it is too close to the fuel pump in the passenger side fuel tank (see following section).

VAPOR LOCK REMEDY FOR 320i's

The 320i fuel reservoir is comprised of two separate tanks mounted under the rear seat. The fuel supply line and return line are both part of the float and pre-pump assembly located in the passenger side tank.

In extremely hot weather, radiant heat from the pavement preheats the fuel in the tanks. The fuel absorbs additional heat from the engine itself as fuel is returned via the supply loop back to the tank. Since this heated fuel returns to virtually the same spot from which it supplies the pump, there is no opportunity for the fuel to cool. Instead it finally absorbs enough heat to change to a vapor, at which time fuel flow is sufficiently restricted to stop the engine.

The most effective remedy we have discovered is simply to move the return line to the driver's side tank, which allows the fuel to cool before it is recycled. The procedure is as follows:

- 1) Remove the back seat, access panel, the fuel supply line, return line, tank vent hose, and electrical connections.
- 2) Remove the clamp and large rubber hose from the filler neck to the passenger side tank.
- 3) Remove the six 10mm head screws that attach both tanks to the undercarriage.
- 4) Pull the front sides of both tanks down simultaneously, then pull forward and down.
- 5) Remove the vent line from the driver's side tank and slide both tanks out from under the car. Drain both tanks if necessary.
- 6) Separate the two tanks, leaving the connecting hose on the passenger side tank.
- 7) Take the driver's side tank to a welder and have a return line, similar in shape but smaller in diameter than the vent line (to accommodate factory sized fuel line), welded parallel to the tank vent line about two or three inches apart.
- 8) While the tank is being welded, locate the steel return line that runs above the front of the tanks. Cut the tubing about half way across the driver's tank. Attach

enough fuel hose to allow you to attach it to the new fitting while still on the ground. Plug the "old" return line.

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9) Remounting the tanks is the reverse of steps 1-6. Remember to attach the vent hose and newly routed return hose to the driver's side tank before lifting both tanks into position. Fill the tanks after installation.

BLOCKED FUEL FILTER

A fuel filter becomes blocked when foreign matter (rust) leaves the fuel tank and is drawn into the fuel filter. As fuel moves through the filter, the particles of foreign matter are deposited on the filter element and cause the fuel flow to be restricted.

Symptoms of a Blocked Fuel Filter:

The car will run as usual for a distance and then begin missing (fuel starvation) and losing power. If you stop the car engine may stall. 10-20 minutes after stalling, the engine will start immediately and run normally. Again after driving a shorter distance, these symptoms reoccur. This pattern occurs because each time you shut off the engine the particles of foreign matter dislodge from the filter element and the fuel restriction is temporarily removed.

Eliminating the Blocked Fuel Filter:

Most problems with blocked fuel filters can be avoided by preventive maintenance. This means changing the fuel filter every 10,000 miles and buying fuel at stations that have high fuel turnover and use fiberglass underground storage tanks.

If you suspect a plugged fuel filter, do the following:

- 1) Remove the fuel filter from the car for inspection. On pre-1977 BMW's, the fuel filter will be on the driver's side of the engine compartment underneath the coolant expansion tank. On 1977 or later cars it will be under the car on the passenger's side of the differential.
- 2) Shake the fuel and foreign matter (rust) out of the inlet side of the fuel filter into your hand. If there is a significant deposit of particles, then there is a good chance the fuel filter is the problem.
- 3) Replace the fuel filter. Even if the fuel filter appears to be free of deposits, if it has not been replaced recently, replace it any way.

Water in the Fuel:

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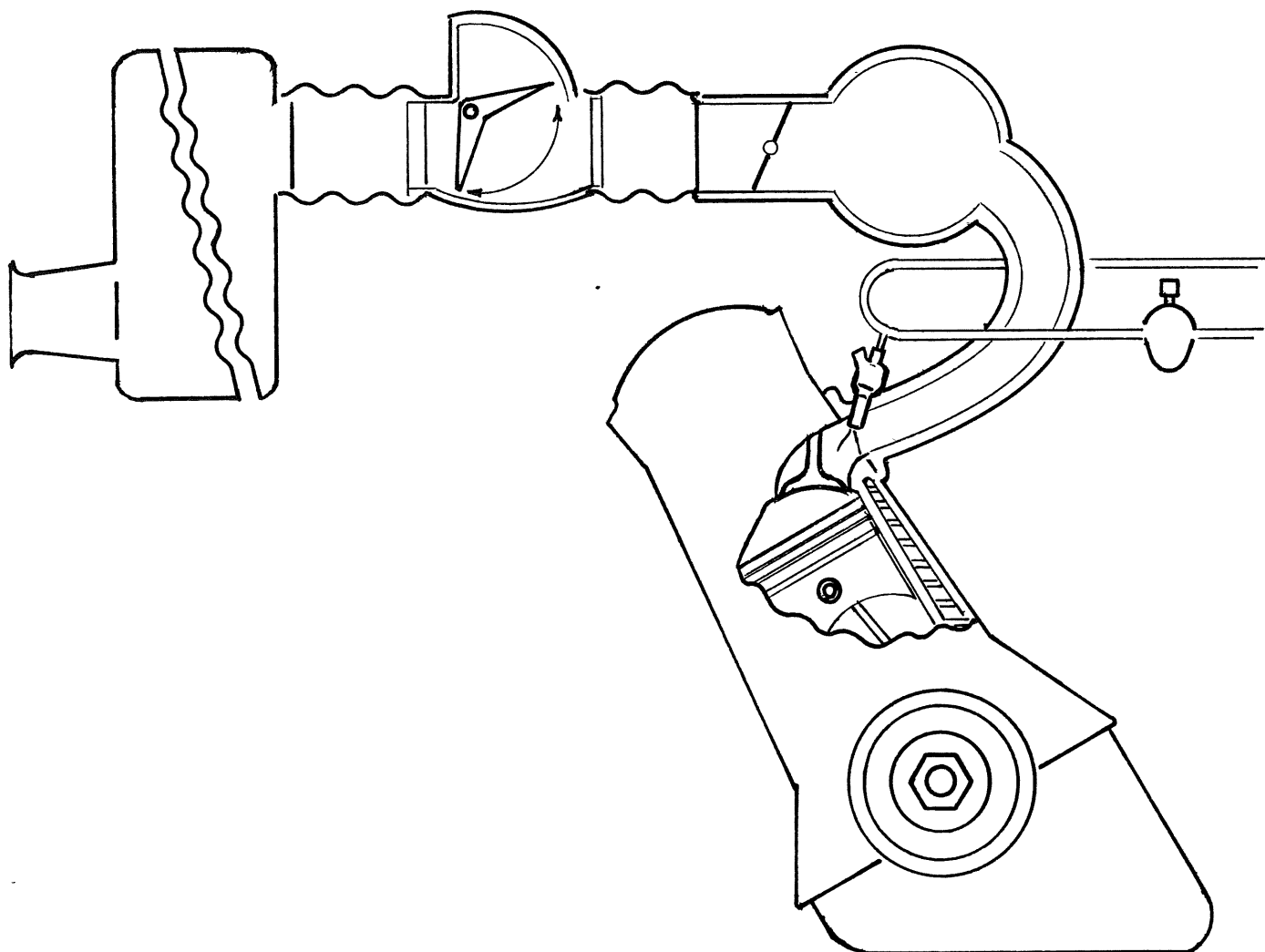
When enough water infiltrates the fuel supply it will cause a restriction in the fuel delivery. Once pumped into your fuel tank NOTHING can remove the water short of draining the fuel tank. No form of alcohol or fuel additives will allow water to pass through the system. We have seen fuel injectors needlessly replaced because of this problem.

Symptoms of Water in the Fuel:

The car will intermittently miss and in severe cases will violently "buck" as you are driving.

Removing the Water From the Fuel:

TO REMOVE WATER FROM THE FUEL YOU MUST DRAIN THE FUEL TANK! The easiest way to drain the fuel tank is to remove the fuel line that connects to the cold start injector and attach a longer length of fuel line (6 or more feet). Run the fuel line into a suitable fuel container. Remove the air intake boot, lift the air flap disk and prop it open with a screwdriver handle. This will allow the fuel pump to activate when the ignition is turned on. Let the fuel pump run until the tank is empty, then pour in another gallon of uncontaminated gas and drain it as well. Before you fill the tank with fresh fuel, you need to replace the fuel filter. When water enters a fuel filter it swells the element causing a fuel restriction. Lastly, remove the screwdriver from the air flow meter door, replace the boot, reconnect the cold start injector line, and fill up the car with fresh fuel. It may take 15-20seconds for it to start because the fuel system will need to purge itself of air.



Bosch L-Jetronic Electronic Fuel Injection System

Bosch first introduced electronic fuel injection in the United States when Volkswagen put D-Jetronic fuel injection on the 1967 Volkswagen Type III. This early system acquired a reputation for undependability. Its bad reputation had more to do with mechanics not knowing how to work on the system than the system's quality. Add this to the very high cost of parts (the brain box was over \$300.00 almost 20 years ago on an "economy" car), and you can see why Bosch was compelled to develop a better electronic fuel injection system.

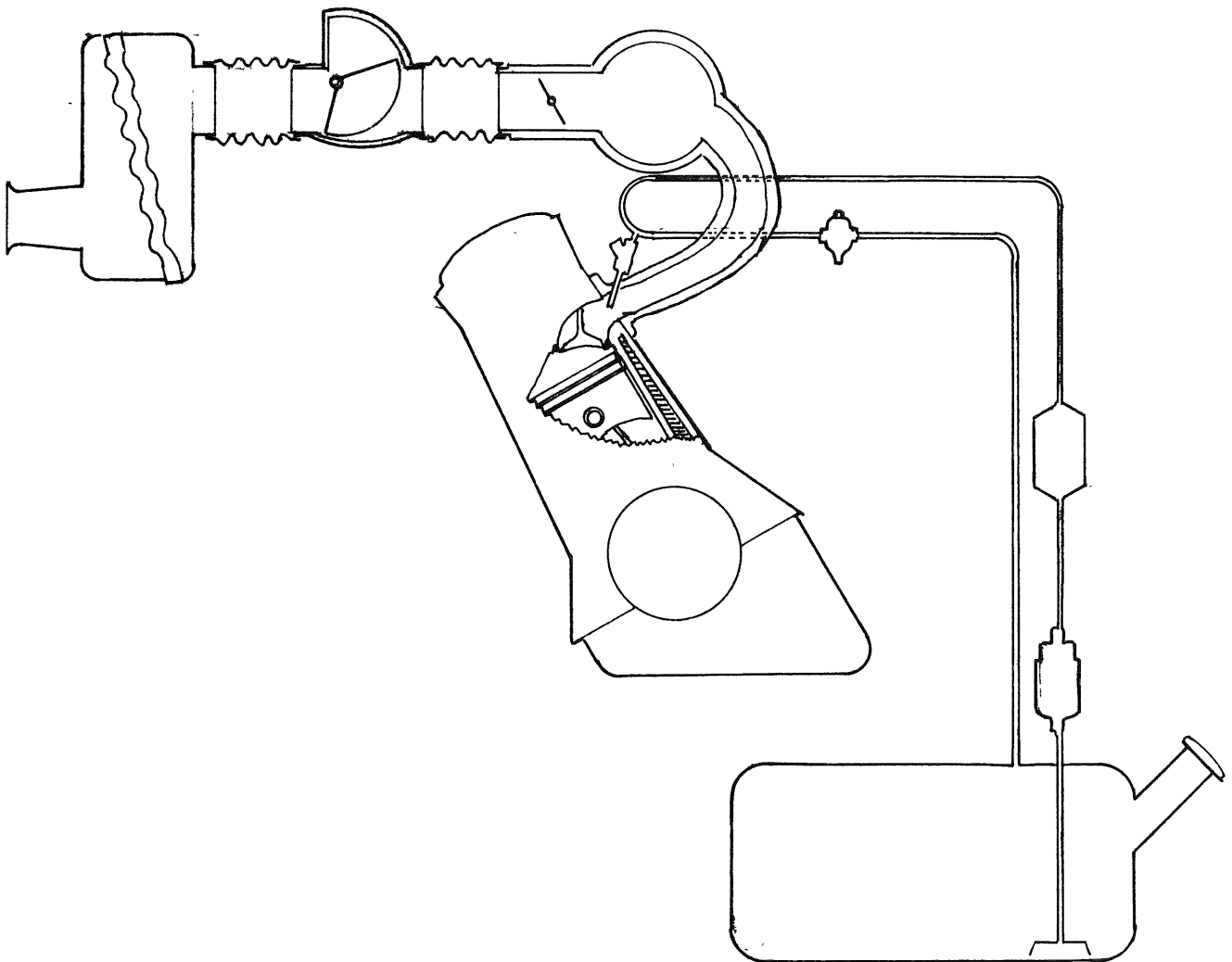
Bosch moved into its second generation of electronic fuel injection when Volkswagen came out with its 1.8 liter L-Jetronic fuel injected engine that was used in the 1974 models of Volkswagen Type IV and the Porsche 914. A year later several manufacturers had switched over to this system, including BMW with its new 5-series car. This system was quite an improvement over the old D-Jetronic fuel injection. The L-Jetronic system retained many of the principles used in the D-Jetronic system but much had been done to reduce the number of components used in the system. This helped make the L-Jetronic fuel injection easier to understand and to work on. The Japanese bought licensing rights to the system and used it on the Datsun 280Z beginning in 1975. Several years later, some American car manufacturers adopted this system. The L-Jetronic system is now the most widely used system in the automotive industry. At the present time, BMW uses a form of L-Jetronic fuel injection on all its U.S.A. models.

Fuel System:

Fuel for the fuel injection system is brought to the injectors via a high pressure electric fuel pump located near the gas tank. A fuel pressure regulator is placed on the end of the fuel supply line and the regulator holds the line pressure at a constant 2.4 bars (35 psi) to the injectors.

Air Intake System:

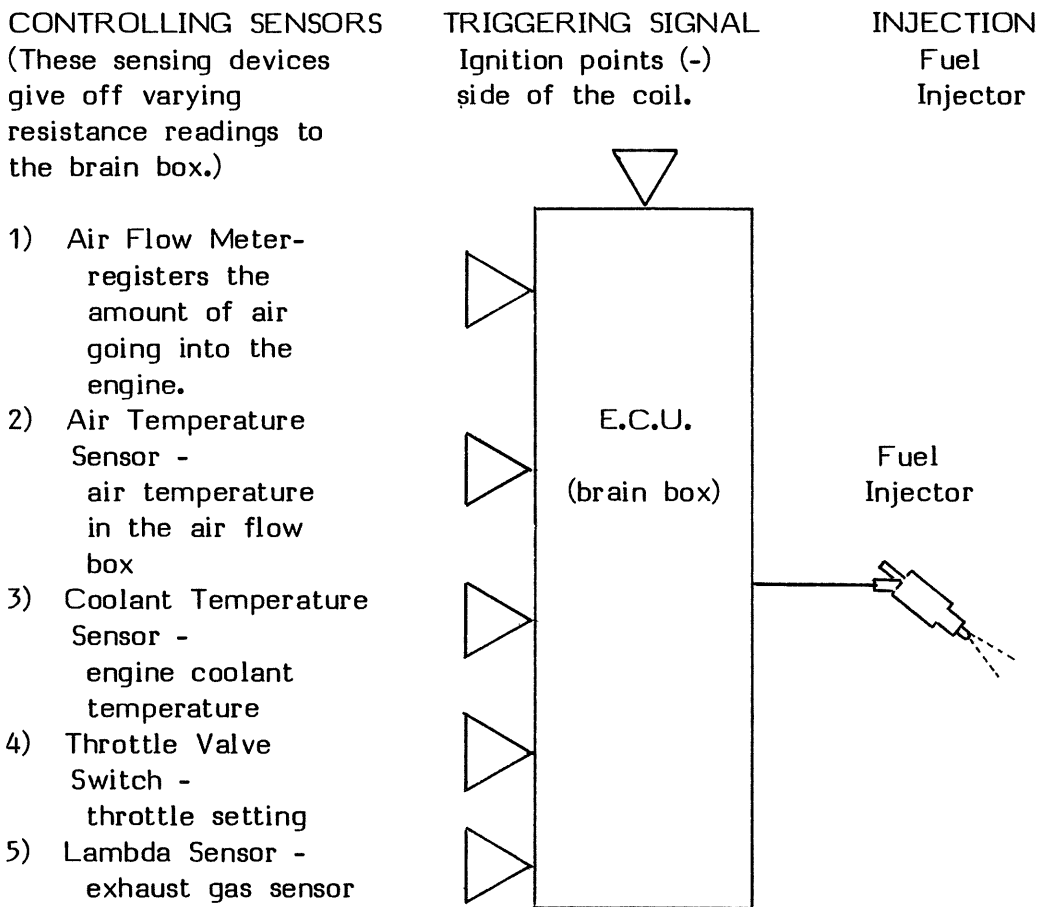
Filtered air is drawn through an air flow meter, the quantity of air being governed by the throttle butterfly. The air then goes into the intake manifold and is delivered into the cylinder when the intake valve opens.



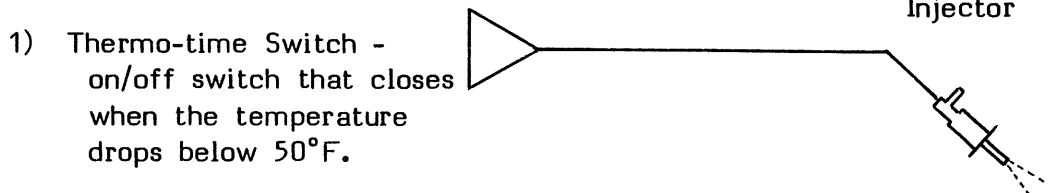
Electronically Controlled Injection:

Several sensors (variable resistors) are placed on the engine to monitor engine conditions. Resistance readings from these sensors are fed into the Electronic Control Unit (brain box) and interpreted. The higher the resistance reading at the sensors, the greater the fuel delivery will be at the injector. When the ignition points trigger the injectors, the injectors are open for the duration prescribed by the brain box to deliver the required fuel quantity.

Normal Operation (above 50°F):



Cold Starting (below 50°F):



Prior to using the charts it will be necessary to first discuss specific trouble-shooting techniques and engine running conditions. Diagnosis of all fuel injection problems will depend on the engine's state of tune, exactly what engine symptoms are manifest and under what conditions. Most importantly, however, your role as a keen observer will be instrumental to successful fuel injection problem solving.

You, the driver, are in the most advantageous position for determining changes in your engine's behavior. Already accustomed to your car's running habits, you will be first to detect any changes in performance. Once detected, what remains is to determine the precise conditions under which these symptoms occur and how they deviate from "typical" engine response. These four conditions are as follows:

Engine Temperature:

If you have owned your car for any length of time you have already noticed the position of the needle on the temperature guage after the engine has thoroughly warmed (15 to 30 minutes of constant running). When warm, the needle should rest at or near half-way, or pointing straight up, on the guage and when cold the needle will be all the way left.

As obvious as this may seem, keep in mind that the engine is designed to function most efficiently within a narrow temperature range (180 - 210°F), represented by the center area of the guage. Operation below this range (left of center) demands that additional requirements be met by the cold start system for smooth, acceptable performance.

Any over heating of the engine (right of center) is indicative of mechanical problems of a higher priority and will have to be addressed prior to any fuel injection work.

Therefore, for the purpose of this manual you will only need to make two distinctions with regard to engine temperature. EITHER the engine is considered "cold" when the needle is all the way left or near the blue rectangle on the guage, OR, the engine is considered "warm" when the needle is anywhere between the left-most white mark to the center area or operating temperature position. The importance of this distinction becomes apparent in the following imperative concerning engine temperature and fuel injection:

WARM ENGINE FUEL INJECTION
PROBLEMS MUST BE RESOLVED
PRIOR TO EVEN ATTEMPTING TO
RESOLVE COLD ENGINE FUEL
INJECTION PROBLEMS!

In other words, all efforts to remedy cold start system troubles will be futile, if all warm-engine problems have not already been resolved. What oftentimes is the case is that alleviating warm engine disorders will lessen the severity of, or perhaps remedy, problems with the cold start system, but never in reverse. For this reason, then, warm engine problems always take priority.

Starting Behavior:

For an engine to start, three conditions must be met. First, there must be adequate compression (75 lbs. p.s.i., minimum) which is a function of the proper mechanical condition of the engine itself, for example, valves, valve timing, and rings, etc. Secondly, presence of and proper timing of ignition is required which has to do with the condition of the battery, ignition switch, starter, ignition coil, distributor, spark plugs and all interconnecting circuitry, relays and fuses. Lastly, the proper quantity and atomization of fuel and air must be present, which concerns all components of the fuel injection system.

By far the most probable cause (approximately 80% of the time) of starting problems involves the ignition system. Of the three systems mentioned above, this one requires the most regular maintenance, and for this reason major service (tune-up) procedures involve replacement and adjustment of the ignition components. Approximately 20% of the time, failure to start will be attributable to fuel related causes, and less than 1% of all starting troubles have to do with cylinder compression or other mechanical aspects. Special precautions must be taken to eliminate ignition and mechanical possibilities before considering the fuel injection system.

Ideally, the engine should start in one to four seconds of cranking, unless it is extremely cold, in which case it might take as long as eight seconds. As a method of testing your car's starting ability, use the following procedure:

- 1) Turn the ignition switch to the running or "on" position.
- 2) Check that both "oil" and "gen" lights are glowing brightly.

- 3) With your foot poised over the accelerator, but not pushing it, turn the key to the "start" position, engaging the starter.
- 4) Let the engine "turn over" until you hear (or feel) it begin to start, then simultaneously depress the accelerator enough to momentarily raise the rpm to about 1500.
- 5) This done, remove your foot from the accelerator to test the engine's self-maintained idle.

Idle Characteristics:

A good percentage of fuel injection problems will manifest themselves by interfering with the smoothness and the rpm level of the idle. If the engine is "cold", the rpm should be higher than when "warm" and usually no lower. Most 320i's will cold-idle between 1200 and 1400 rpm for the initial two minutes, at which time there will be an abrupt drop to warm-idle or even slightly lower (1979 320i's tend to idle at or only slightly above "warm " idle rpm through the entire cold-start sequence). Six cylinder models up to early 1980's will cold-idle between 1400 and 1700 rpm, and later models between 1200 and 1400 rpm (approximately 1000 rpm) at least by the time they have warmed to operating temperature.

When trouble-shooting a "cold" engine, as quickly as it starts and you have observed its idling characteristics, you will need to perform a test procedure by "blipping" the accelerator. That is, as swiftly as possible and in one continuous motion, depress the accelerator halfway and remove your foot, quicker than the pedal will remove of its own accord. What you are testing is the immediacy of the engine's response, its smoothness and its willingness to rev freely. It should behave just as it does when "warm", assuming that warm engine performance is correct. That is, there should be no hesitation or stumbling and the engine's response should be instantaneous with accelerator movement and free spirited.

Test-Drive Characteristics:

All remaining fuel injection disorders can be diagnosed by test driving the car. The purpose of this procedure is to examine your engine's responsiveness while "under load" and cruising. Those with automatic transmissions should shift through each gear manually for this procedure.

- 1) With traffic at a minimum on a long stretch of road, accelerate in first gear from a stop (accelerator depressed fully) to a minimum of 4000 rpm.
- 2) Listen and feel for smooth, constantly increasing speed with no jerkiness or hesitation.

- 3) Shift to second gear and again fully depress the accelerator, revving the engine to at least 5000 rpm.
- 4) If you do feel any hesitation or lurching, repeat the above steps enough times to determine the consistency and rpm level of the symptoms.
- 5) In addition, note any particular rpm at which the engine "struggles" or refuses to reach (max. 6400 rpm)
- 6) Finally, at some point in the test-drive, in third or fourth gear, "cruise" in the car. That is, on level terrain, hold the accelerator to maintain a constant velocity. The engine should run very smoothly with no jerkiness.

Now that you have completed the start-up, idle and test-drive procedures, carefully observing your engine's behavior, you are nearly prepared for diagnosing in accordance with the trouble-shooting charts that follow. Before doing so, there are three very important considerations:

- 1) YOUR CAR IS THE VERY BEST DIAGNOSTIC TOOL AVAILABLE. There are specific running symptoms for each and every fuel injection flaw that can occur and your familiarity with your engine's behavior will manifest them. Don't think that because you do not have access to a state-of-the-art diagnostic machine that you will be unable to completely maintain your fuel injection system. These machines are limited by a) the selection of components that can be checked, b) how components are judged to be "defective" -i.e. there is no distinction made between "out of adjustment" and "defective", and c) its inability to perform test-drive diagnosis, which ultimately rests in the hands of the person behind the wheel.
- 2) Beware of the phrase - "That's just the way these cars run". If you have doubts about your car's performance, have your trusted friend and/or mechanic test it. Better still, test drive the same model belonging to someone else, to give yourself comparative data.
- 3) We cannot overstress the fact that many of the symptoms you will experience will be attributable to ignition and mechanical problems and not just fuel injection ones. In most instances, a quick check of these non fuel-related probable causes will facilitate trouble-shooting and repairing your fuel injection.

TROUBLE-SHOOTING CHART #1 STARTING PROBLEMS

<u>STARTING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
When key is turned to "start" position engine will not turn over	Battery is dead or weak	80%	When jump starting, attach jumper cables to auxiliary terminals on plastic factory clamps. Consider replacing any battery that is four years or older as much of its cranking power is gone.
	Battery cables corroded between posts and clamps	16%	Inspect for dark gray or black surface on battery posts and inside of cable clamps. Cut clamps off and replace <u>or</u> remove and clean until contact surfaces shine. Reconnect clamps and tighten. Remove and clean body and engine grounds. Remove and reclean battery clamps and posts, replace and retighten.
	Starter connection(s) or solenoid problems	2%	Inspect solenoid for loose connections at battery terminal (battery cable attached), ignition switch terminal (larger push on) and injection terminal (smaller push-on). Recrimp if necessary. As a test, use a screwdriver blade to connect ignition switch terminal to battery terminal on the solenoid, bypassing the ignition switch.
	Ignition switch defective	1%	With a screwdriver blade, connect ignition switch terminal to battery terminal on solenoid, bypassing the ignition switch. Also use a test light to verify current at ignition switch terminal wire with key in "start" position.
Starter engages, but engine turns over slowly	Battery weak &/or connections corroded	85%	See above procedures.

TROUBLE-SHOOTING CHART #1
STARTING PROBLEMS
Continued

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<u>STARTING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
(Continued)	Starter "drags" (battery charged)	12%	Starter rear bushing support (composed of nylon) for armature worn. Replace starter or fabricate replacement bushing.
	Engine oil too thick (cold weather)	2%	Replace with multiple viscosity oil (10W-40 or 20W-50)
Engine turns over well but refuses to start	Fuel pump not activating	25%	While someone else turns over the engine, listen for fuel pump humming sound underneath car just outside right rear wheel. If no sound, inspect: Air flow meter door restriction; Air flow meter electronic connection; Massive intake leak, e.g. split intake bellows; Double relay and connections; Fuel pump connections & fuse
	Ignition system breakdown between positive coil terminal and high tension coil wire	75%	Remove coil wire from distributor cap. Insert screwdriver blade into plug wire end while holding blade 3/4 - 1" from a ground (e.g. valve cover). An intense blue-white spark should occur. If spark is weak, intermittent or not present, replace points and condenser. Also inspect coil wire resistance, corrosion under coil wire boots, the center electrode inside distributor cap for wear or absence, defective rotor, current at positive coil terminal or points contact's for obstruction. (Those with electronic ignition refer to Factory Manual).

TROUBLE-SHOOTING CHART #1
STARTING PROBLEMS
Continued

<u>STARTING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
(Continued)			
Special Conditions	Moisture obstructing ignition (wet or high humidity conditions)	100%	Dry ignition with moisture displacer, hair dryer, rag, etc., from points, distributor cap, plug wires and boots, coil and coil wire.
	Engine "flooded" - spark plugs fuel soaked (cold engine)	100%	Three conditions cause fuel to foul spark plugs: Too much fuel to adequately vaporize Temperature too cold for adequate vaporization Voltage drop at primary side of ignition, causing weak spark.
Engine starts <u>only</u> after prolonged cranking	Fuel pressure initially too low (warm engine)	100%	Replace fuel pump check valve (Fuel Pump Section)
	Fuel mixture initially too lean (cold engine)	100%	Inspect thermo-time switch/cold start valve circuit (See Section)

BEFORE REFERRING TO CHART # 2, The Ignition System Must Pass This Definitive Test:

Remove plug wire from spark plug and insert tip of screwdriver into plug insulator, holding screwdriver shank no closer than 1/4" from a ground (valve cover cap nuts) turn ignition to "start" position and inspect for bright, blue-white spark, sufficiently intense (fat) to bridge gap of 3/4 - 1". Remove spark plug, reconnect plug wire, ground spark plug and turn ignition to "start".

IF spark observed is rhythmic and adequately intense, refer to Chart #2
IF spark observed is weak (yellow/orange), intermittent or not present, repeat Chart #1 procedures.

TROUBLE-SHOOTING CHART #2 L-JETRONIC FUEL INJECTION

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<u>RUNNING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Poor overall performance and/or rough running	Engine poorly tuned	60%	Perform minor tune-up, including replacement of spark plugs and condenser, and setting timing. We suggest Bosch products for greatest longevity. Lightly lube distributor cam lobes with grease, set point gap at .016", and time engine according to factory sticker.
	Ignition system functioning, but weak	4%	Remove coil wire from distributor, insert screwdriver tip into coil wire end and hold shank 1/4" from ground (valve cover cap nut). While engine cranks, check for intense blue-white spark. If spark is weak or yellow-orange inspect the following: Coil wire corrosion (powdery green deposits on terminals) or internal resistance. Coil weakening, spark intensity fluctuating Condenser weak. Engine misses sharply while under load and/or barely runs.
	Fuel Mixture too lean	35%	Air flow meter needs recalibration (most likely) Fuel pressure regulator is defective Brain box (injection computer) defective
IDLING: a) Low and rough tendency to die	Fuel mixture too lean	39%	Intake leaks (see section) Reset CO and/or recalibrate air flow meter (see section)
	Ignition timing too retarded	60%	Reset timing on "Z" and not "T0" steel ball (manual transmissions) and long peg instead of short peg (automatic transmissions).

TROUBLE-SHOOTING CHART #2
L-JETRONIC FUEL INJECTION
Continued

<u>RUNNING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
b) Excessively high	Throttle bypass air flow is excessive	14%	Deceleration valve adjustment (Auxiliary Air Valve sect.) Throttle valve stop incorrectly adjusted. Auxiliary air valve open when engine is "warm"
	Ignition timing too advanced	85%	Reset timing as above Distributor centrifugal advance weights fixed in "advanced" position Vacuum retard line disconnected or leaking Distributor points plate frozen Vacuum retard diaphragm defective
c) Rythmically, oscillating idle	Fuel mixture too rich	2%	Oxygen sensor failure (see section) CO setting incorrect (Air Flow Meter section)
Missing on one or more cylinders <u>when cold only</u>	Coolant in combustion chamber(s)	100%	Replace or repair cracked cylinder head.
Missing one or more cylinders at <u>all</u> temperatures	Ignition system breakdown between positive coil	80%	Remove each plug wire from distributor cap individually to check for corrosion (powdery green deposits), then replace With engine idling, again pull each plug wire from the cap <u>one at a time</u> , until arching stops. Idle rpm should lower for each individual cylinder. If, for one or more cylinders, the rpm does <u>not</u> lower, this cylinder is not

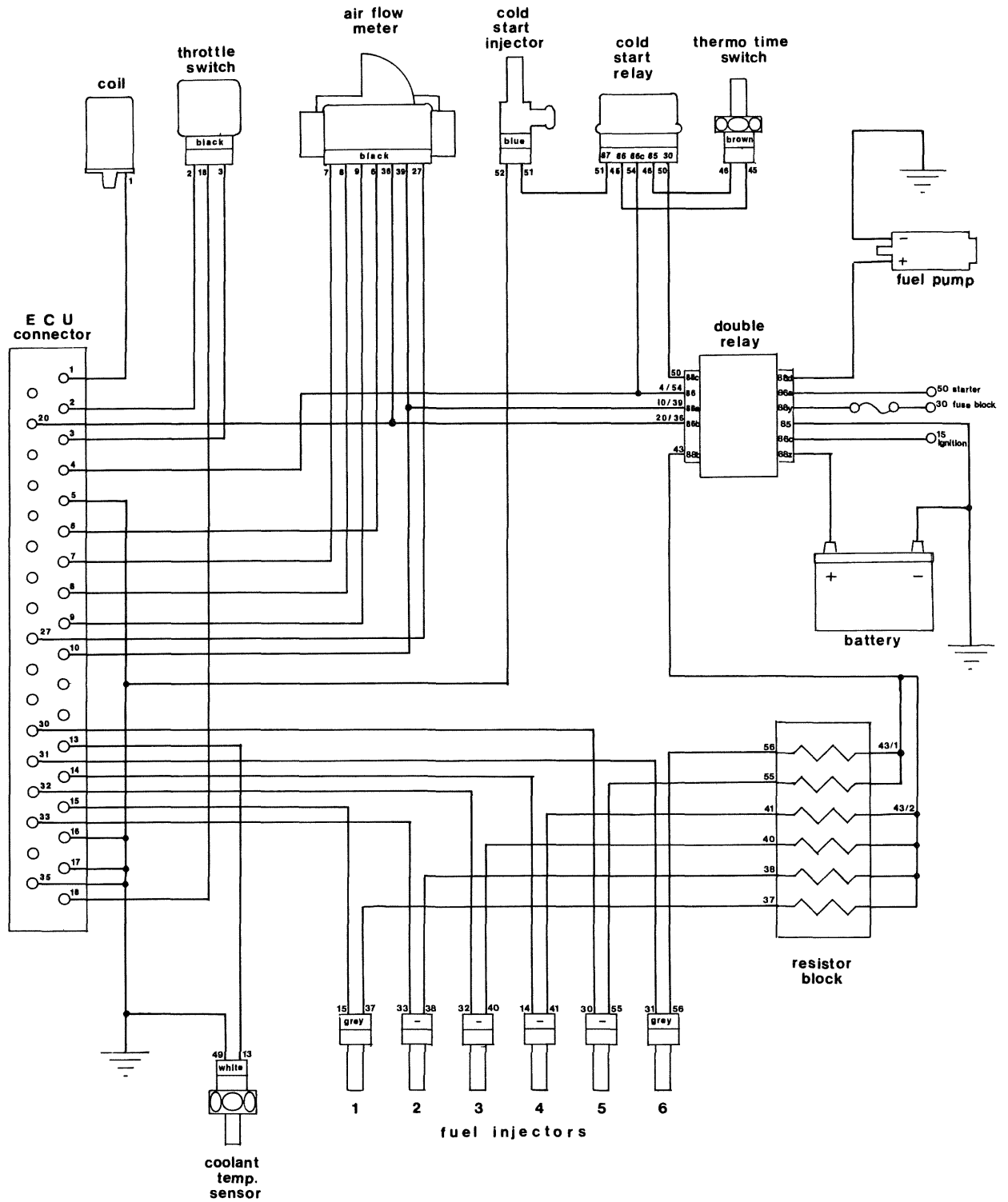
TROUBLE-SHOOTING CHART #2
L-JETRONIC FUEL INJECTION
Continued

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<u>RUNNING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
(Continued)			firing and one or more of the following problems exist: Spark plug(s) worn or fouled Defective spark plug wire or plug insulator (resistor inside of insulator burnt-out) Distributor cap cracked &/or carbon tracks inside Plug wires crossed. Check for correct firing order
	Fuel mixture too lean at individual cylinder(s)	16%	Vacuum leak at respective intake runner.
	Inadequate compression	2%	Valve(s) burnt, bent or incorrectly clearanced.
	Circuit open	>1%	Inspect injector electrical connection.
Intermittent missing (occasional "bucking")	Water in fuel	85%	Fuel tank must be drained (Fuel Pump section)
	Inadequate fuel delivery	10%	Fuel filter restriction (Fuel Pump section)
	Ignition breakdown	4%	Ignition coil or condenser defective.
Intermittent loss of power and dying	Insufficient fuel delivery	>1%	Vapor lock - remove gas cap to vent tank (Vapor Lock section)

TROUBLE-SHOOTING CHART #2
L-JETRONIC FUEL INJECTION
Continued

<u>RUNNING SYMPTOMS</u>	<u>PRIORITIZED CAUSES</u>	<u>%</u>	<u>SOURCES OF PROBLEMS/REMEDIES</u>
Poor high rpm performance	Ignition "cut-out"	30%	Spark plugs worn or fouled
	Ignition timing	30%	Reset timing in accordance with factory sticker.
	Insufficient fuel delivery	30%	Air flow meter door sticking or cracked (see section)
	Engine "broken in" incorrectly	6%	Engine has been pampered and will be reluctant to or will refuse to rev over 5,000-5,500 rpm.
	Restricted throttle movement	3%	Large hose clamp on throttle housing restricting full throttle arm movement.
Excessive fuel consumption (less than 10 mpg)	Engine poorly tuned	80%	Refer to beginning of CHART #2
	Fuel leakage (raw fuel odor)	10%	Fuel tank leaking at seam when over half full. Fuel lines, fittings or injectors leaking.
	Resistance readings to brain box too high	9%	Air flow meter door sticking (see section). Sensor wire(s) disconnected Coolant or air sensor defective (Sensor section).
	For majority of the running engine is well below operating temperature (cold weather)	>1%	Almost entirely short distance driving. Prolonged warm-ups.

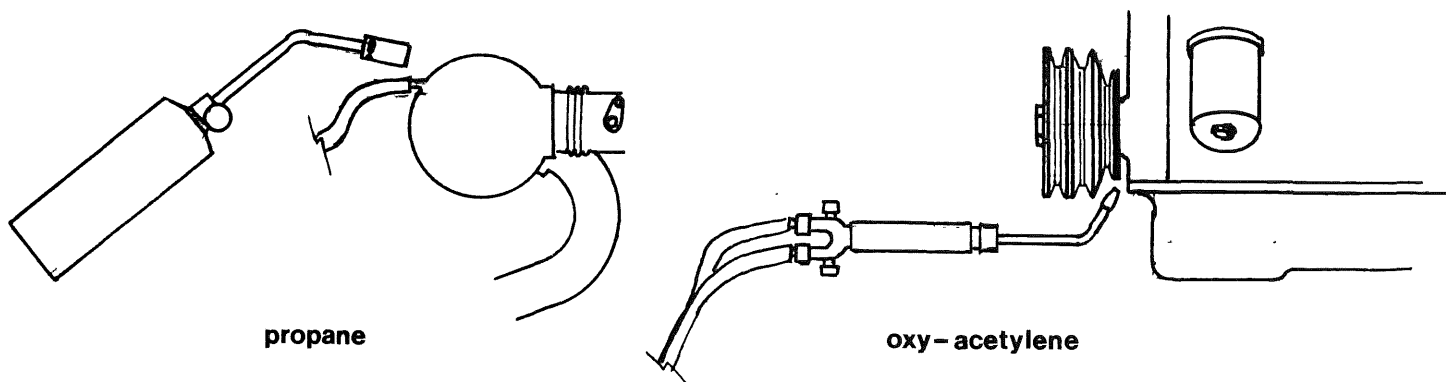


Most weak lean idles are caused by vacuum leaks. Engines equipped with L-Jetronic fuel injection have to be totally sealed from the atmosphere. Any air not registered by the air flow meter will create a weak lean mixture at idle. For example, if you pull the dip stick out of the dip stick tube while the car is running you will observe that the engine either develops a weak idle or dies .

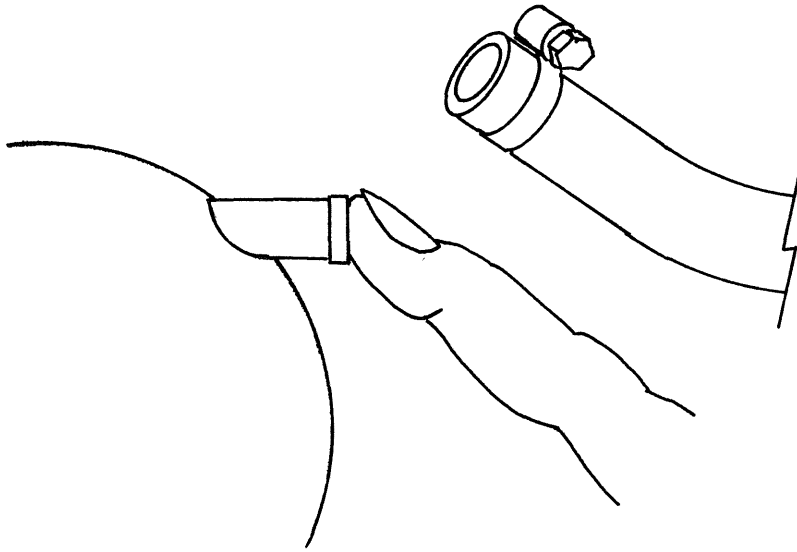
How to Locate Vacuum Leaks:

To find a vacuum leak you will need a flammable gas or liquid, the higher the gaseous state the better. For example, an acetylene torch (gas welder) or a propane torch will work better for finding leaks than using starting fluid. Obviously, a gas can be taken through a small vacuum leak easier than a liquid. Also, fire hazard is greatly reduced because the gas rises and leaves the work area. When performing the following operations it would be wise to have a fire extinguisher within reach.

To pinpoint the exact location of a vacuum leak, with the engine running, point the torch tip at the suspected vacuum leak. Open the gas valve on the torch. A vacuum leak will draw the gas into the manifold, which will richen the mixture. If the idle increases you have located a vacuum leak.



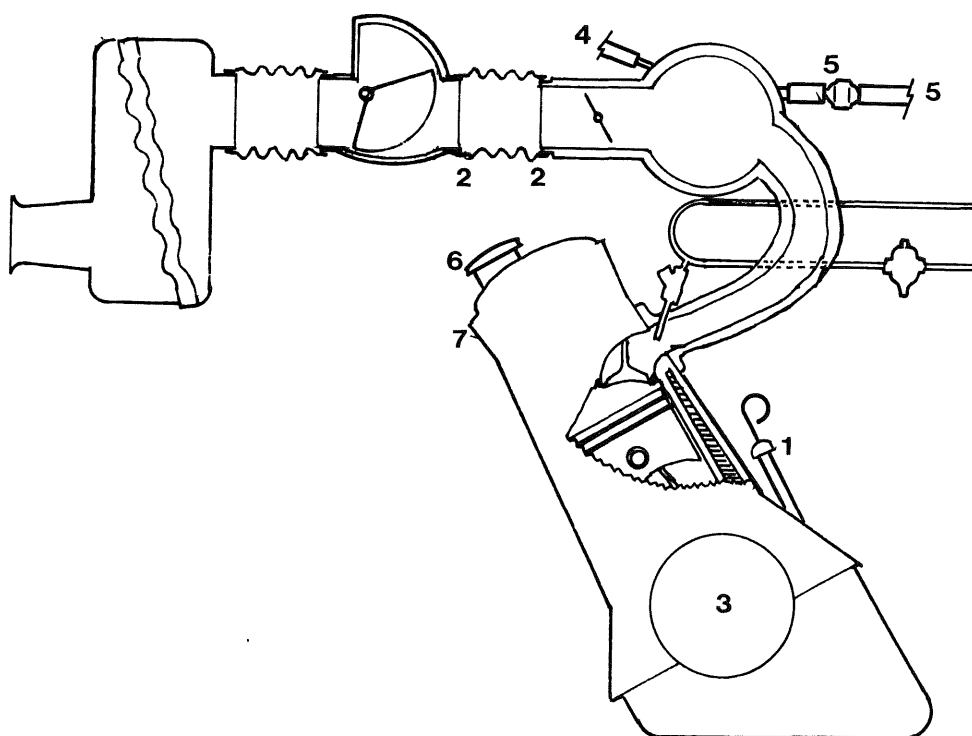
If you suspect a vacuum line leak, an easy check is to pull off the vacuum line and plug off the manifold hole with your finger. If the idle picks up or smooths out, you have found a leaking vacuum line.



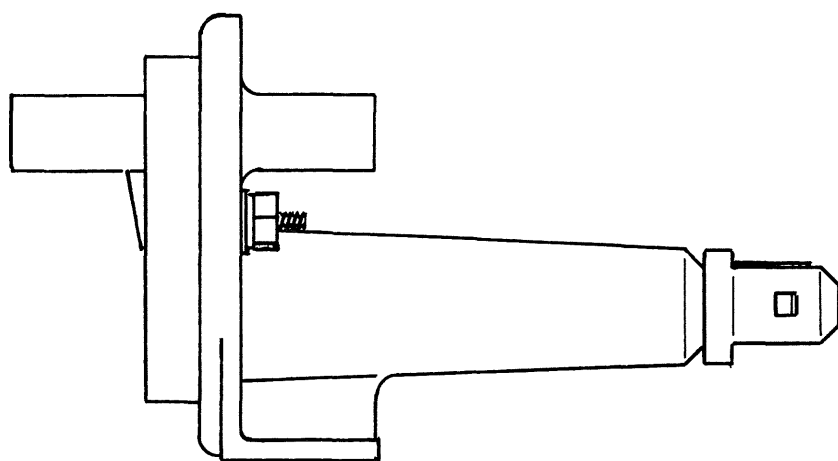
Most Common Vacuum Leaks:

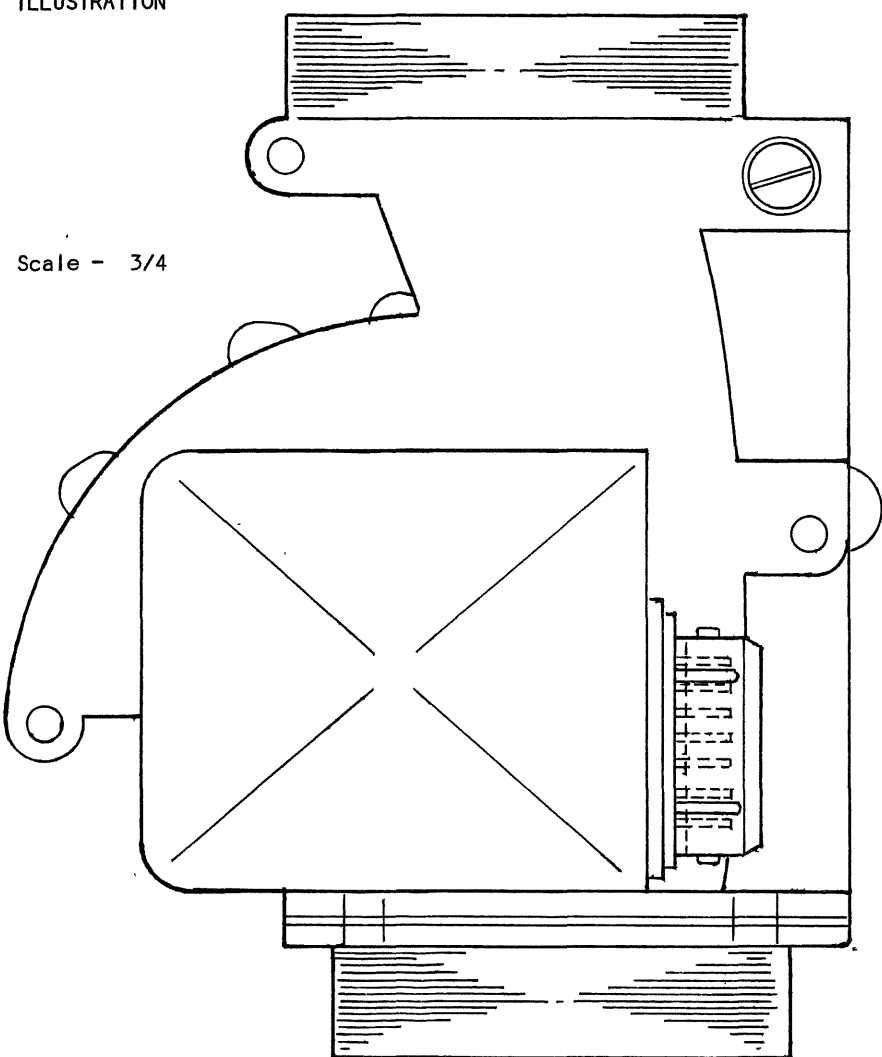
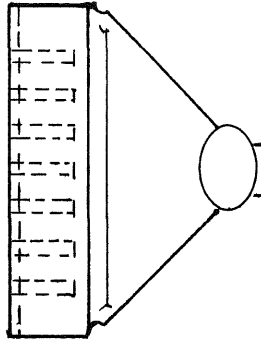
Here is a list of the most frequent vacuum leaks:

- 1) Dip stick partially pulled out.
- 2) Air intake boot split between the air flow box and intake throttle valve.
- 3) Air is leaking into the engine via the front cover seal or rear crankshaft seal. This leak happens every so often and is difficult to locate and fix.
- 4) Vacuum lines off or leaking.
- 5) Vacuum brake booster line or diaphragm leaks.
- 6) Oil cap leak.
- 7) Valve cover gasket leaks.



Repair all vacuum leaks as needed and set the idle. If the idle still appears to be weak, recheck the ignition timing (it may be retarded). Knowing the car is in a good state of tune and after thoroughly attempting to fix all vacuum leaks, if the idle is still weak, recalibrate the air flow meter. Recalibrating the air flow box can compensate for any remaining minor vacuum leaks (see following section).



PART AIR FLOW METER	SENSOR
ILLUSTRATION  Scale - 3/4	ELECTRICAL CONNECTOR Identification and color code  BLACK
PART NUMBERS Air flow box... 1975 & 1976 ... Bosch 0 280 203 001 (Air flow meter) 1977 & 1978 ... Bosch 0 280 203 004 6331 & 7331 1979..... Bosch 0 280 203 004 1979 - on Bosch 0 280 203 011	COMMENTS Air flow box 0 280 203 004 can be substituted for 0 280 203 001.
SPECIFICATIONS The Air flow box door spring tension is set at apx. $1 \frac{1}{6}$ turns from the factory.	

Location:

The air flow meter is directly over the valve cover, one end is connected to the throttle valve housing and the other to the air filter box. On 1975 and 1976 models the meter will be mounted to the inner fender wall instead of to the engine itself.

Function:

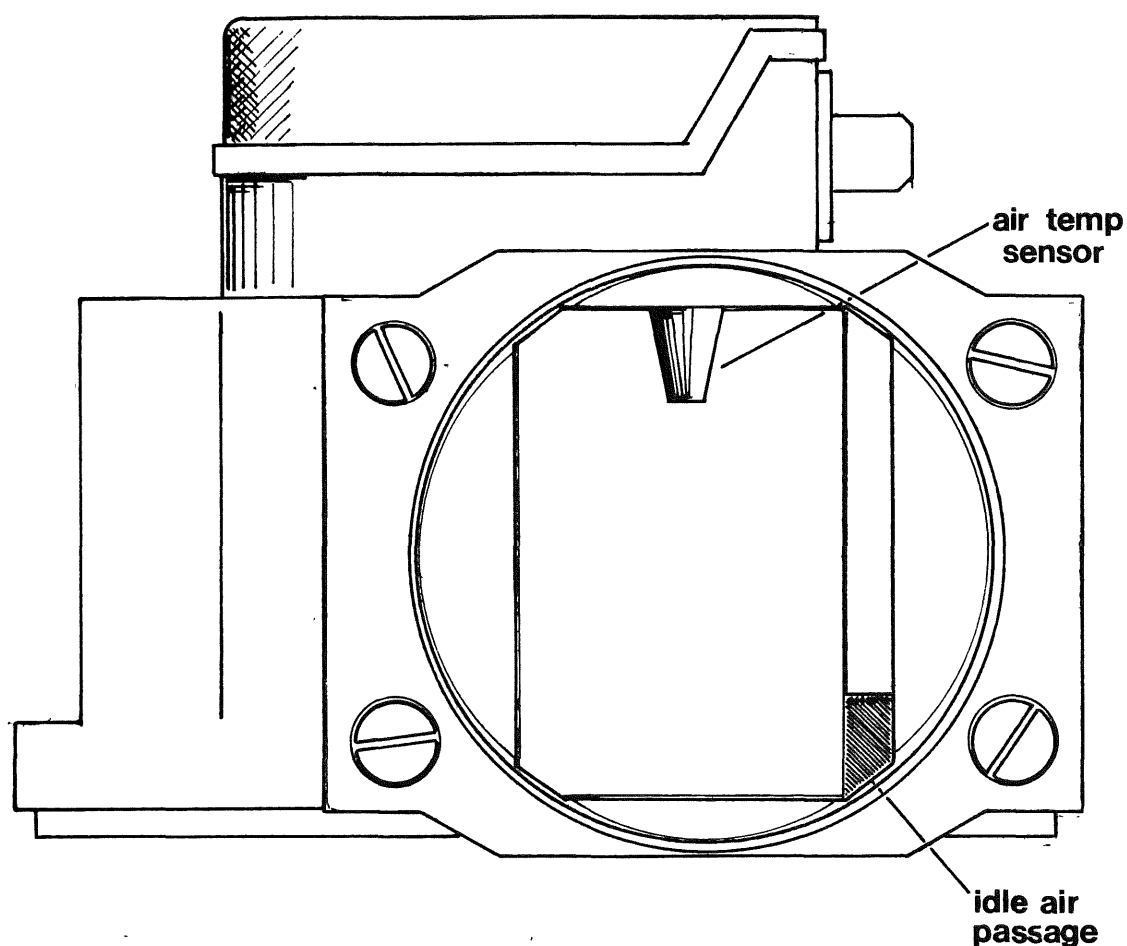
The purpose of the air flow meter is two-fold. First, it measures the instantaneous volume of intake air, as determined by the throttle valve position and the engine load, by means of an aluminum "door". Secondly, the meter registers a specific resistance reading, for fuel delivery, that directly corresponds to any given position of this door. Also incorporated within the air flow meter is an ambient air sensor whose resistance varies according to the temperature of the intake air. Finally, there is a ground switch, integral with the fuel pump relay circuit, that closes (completes the circuit) or opens (breaks the circuit) when the meter door is open or fully closed, respectively.

Symptoms:

If you have been directed here by the trouble-shooting guide, one or more of the following running symptoms are manifest:

- 1) General loss of power (especially before the engine has warmed to operating temperature).
- 2) Backfiring in the intake manifold during cold starts (this should be avoided at all costs, for irreparable damage to the air flow meter door is likely).
- 3) Low, weak idling.
- 4) Missing during high rpm acceleration.
- 5) Light grey to "chalky" exhaust pipe color.

If any of these symptoms describe your 6 cylinder BMW and you are convinced of the engine's mechanical soundness and proper state of tune (ignition system), then what is required is an air flow meter recalibration. Before adjusting however, it will be necessary to dissect the meter into its mechanical and electronic elements, understand how each one functions and how they all cooperate to determine the appropriate fuel/air mixture for any given set of engine operating conditions.



Removal From Engine Compartment:

1975 & 1976 Models - Loosen the large hose clamp that attaches the air bellows to the throttle valve housing. Work the bellows off the housing, unplug the electronic connector from the front side of the meter and pull up on the meter and air filter box, simultaneously, to slide them off their respective mount rails. Once totally removed from the engine compartment, loosen the clamps and remove both bellows from the meter.

1977 & Later Models - Loosen the hose clamp that connects the air bellows to the throttle housing and remove the two 10mm nuts and washers that fix the air meter/filter bracket to the inner fender wall. Unplug the electronic connector from the left side of the meter and remove the whole assembly from the engine compartment. From the

- 104 underside, remove the three 10mm nuts that attach the air flow meter to the rubber mounts. Loosen the "elbow" duct clamp on the meter and disengage the meter from the bracket.

Detailed Description:

Sight into the input port of the air flow meter. The conic shaped probe hanging from the top of the opening to the rectangular tunnel is the ambient air sensor. Just behind the probe, is the pivoting, spring-loaded door that is activated by the flow of intake air required by the engine. Actually, the door is a double one, with another flap 120° counter-clockwise to it (that can be viewed from the output port), for the purpose of dampening and supplementing structural strength. Activate the door with your hand to the wide open position and back again to test for freedom of movement. There can be no rubbing, sticking or any indications of the same (e.g. a "squeak" or scraping sound), otherwise the meter is useless. Any such movement restriction/door warpage is the result of intake manifold backfiring during cold-engine starting.

At the lower right hand corner of the rectangular, intake port opening is a smaller (approximately 11mm x 17mm) hole leading to an air passage way that runs the length of the meter to another similar opening at the output port. Through this smaller passageway, at or near idle rpm only, flows unmetered air that functions like a controlled intake leak by leaning the fuel mixture. Simulate the movement of the door during operation and note the difference in the cross-sectional area of the tunnel exposed by the first 15° to 20° and the last 15° to 20° of total door movement. Whereas the last few degrees represent as much as 50% of a tunnel opening increase, the first few degrees of movement expose only 5% to 10% of the total tunnel cross-sectional area.

Therefore, at idle rpm, the door has not opened far enough to expose a greater cross-sectional area than that of the smaller opening of the CO passageway. Air will continue to flow through this passageway until there is a greater cross-sectional area exposed (i.e. a path of less resistance to air flow) by the door position.

The spring loaded door only controls the maximum amount of air flow through the CO passage at any given time, which is always more than necessary for a proper idle fuel mixture. Precise control over the passageway air is governed by the CO screw, that is accessible from the top (where the black plastic cover plate is located) of the meter, near the bottom of a hole that is next to the outlet port (it will either have a slotted or hex key head). Turning the screw clockwise will restrict the CO passage, forcing more air to affect the door position, while counter-clockwise rotation will divert air from the door into the CO passageway. In actuality then, any air flowing through this passageway, although not technically "metered" (i.e. for

any given amount of air flow "x", there is a corresponding increase in door travel "y") does cause the door to retract the same distance it would advance if there were no passageway at all.

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Pre-Adjustment Test:

Before removing the black plastic cap for air flow meter adjustments, perform the following test to verify that your meter is in need of recalibration.

- 1) Re-clamp the air bellows on the output port of the meter.
- 2) Re-clamp the other end of the bellows to the throttle housing.
- 3) Be certain that both clamps are tight and that there are no splits or cracks in the bellows itself. There cannot be intake air leaks of this kind while adjusting the meter.
- 4) Reconnect the electronic plug-in (it only goes one way) and let the meter hang or rest on the valve cover.
- 5) While the engine idles, use your finger to gently push on the door. Immediately, if an adjustment is needed, the idle rpm will increase and the engine will run smoother. Continue pushing until the rpm begins to lower and the engine starts missing intermittently. Release the door and allow it to return to its previous position.
- 6) Repeat step #5, while holding the throttle valve partially open to maintain, as steady as possible, approximately 3,000 rpm.
- 7) If the highest rpm and smoothest operation occur only when your finger advances the door position, you do need an air flow meter adjustment. On the other hand, if the "best" idle operation is self-maintained and pushing the door makes the idle rpm drop or the engine run rougher, the meter needs no adjustment (see L-Jetronic troubleshooting guide).

NOTE: Unplug the oxygen sensor before adjusting the air flow meter.

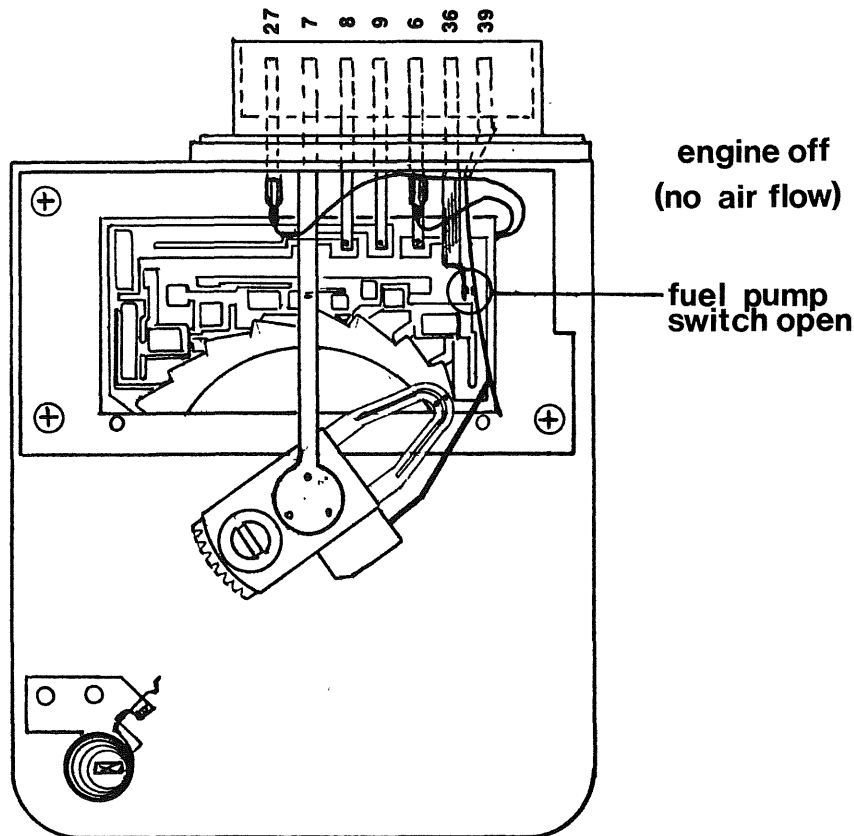
Adjustments:

Once again, loosen the hose clamp, detach the electronic plug-in and remove the air flow meter from the engine compartment.

- 106 The uppermost part of the meter is covered by a large, black plastic cap bearing the Bosch name and part number. Scrape as much of the clear silicone sealant as you can off of the cap's perimeter with a small and with a large screwdriver pry at the cap on all sides, doing as little damage as possible, until it is removed.

As you are looking as what is under the cap, alternately advance and retract the spring-loaded door. The part that you see moving is called the "pointer". It is directly anchored to the same pivot shaft as the door in the air tunnel.

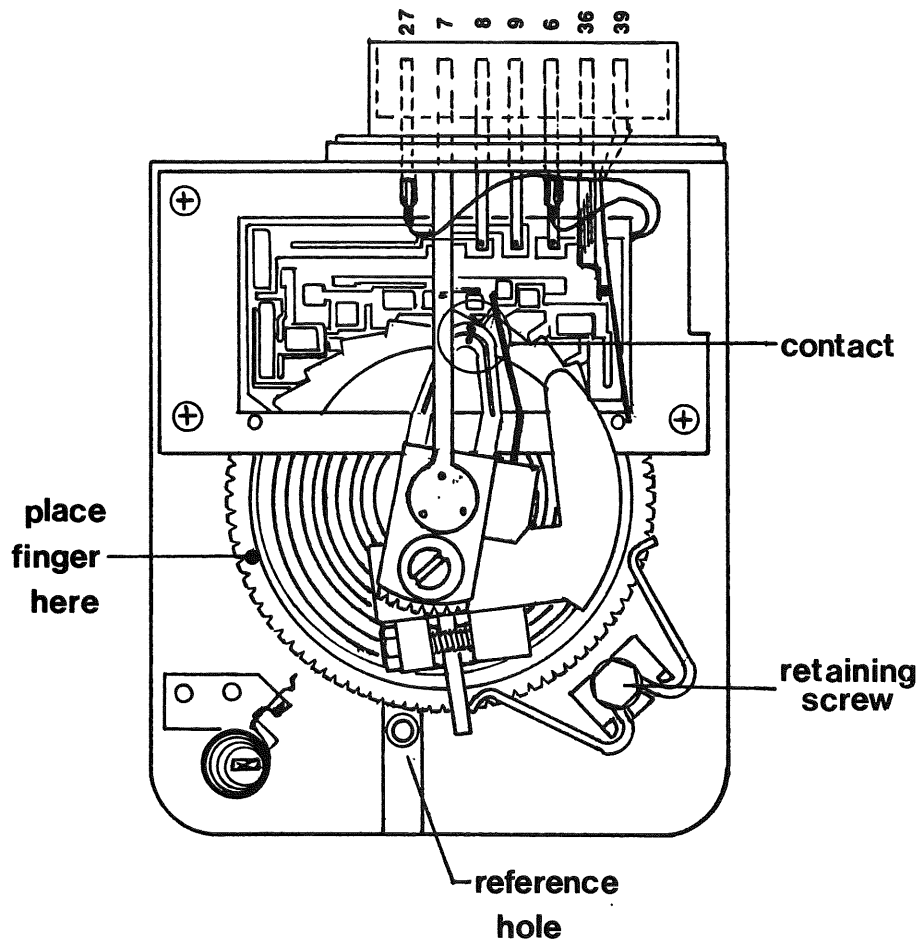
IMPORTANT: A given amount of movement of the door corresponds directly to a like movement of the pointer.



The copper double loop contact (see illustration) rides on a resistance track that yields increasingly greater resistance readings for each increment of door advancement. The heavy gauge wire rod projecting

from the pointer, over the contact loop, opens the fuel pump electrical circuit, when the door is at rest, preventing the pump from operating.

Directly under the pointer is the coil spring, one end of which is attached to the pivoting shaft and the other to the toothed black ring. The spring load on the door is a consequence of approximately one and a half turns of the ring, whose tension is held by another heavy gauge wire and a 7mm head screw (or a straight slot screw and tab on early models).



As mentioned before, the pointer's contact loop tracks on the black resistance arc on the printed circuit board. The design of the circuit board is such that a continuum of resistance from low ohms (door

closed) to high ohms (door fully opened) is relayed to the computer "brain", depending on the placement of the pointer (whose position is a direct function of the air flow demands of the engine at any given rpm).

Recall that L-Jetronic vital engine information to the "brain" is in the form of resistance readings and that gradually, engine parameters change due to component wear and general engine deterioration. Therefore, what is accomplished by adjusting the air flow meter is to increase the resistance readings (richening the fuel mixture) for all door positions. This is exactly what occurred during the pre-adjustment test performed earlier when the door was advanced further than under normal operation. Richening the overall fuel mixture can be theoretically realized by either: advancing the position of the pointer with respect to the door or decreasing the door spring tension. The first method has limited applications and risks damage to the pointer contact, while satisfactory results in virtually all situations occur when implementing the method described below.

- 1) Re-clamp the bellows to the air flow meter and reattach both to the throttle housing in as upright a position as the plug-in connector allows.
- 2) Start the engine and allow it to fully warm to operating temperature. With a straight blade screwdriver (allen key - later models) rotate the idle CO screw clockwise until it bottoms in the bore, then rotate it counter-clockwise two turns.
- 3) Scratch a mark, with the screwdriver, on the black ring tooth that is closest to the small reference hole in the meter housing (see diagram). This is to mark the original position of the spring.
- 4) With the engine idling, advance the position of the spring-loaded door with your finger while you closely observe the exact position of the pointer. As you richen the mixture the idle rpm will increase and the engine will run smoother. Keep pushing until the rpm begins to drop and the engine starts to miss and run rough. Repeatedly advance and release the door until you have determined the arc distance on the resistance track (approximately 1mm) where the engine runs smoothest and the idle is highest; this represents the "ideal mixture range".
- 5) Firmly place your left index finger on the "full-throttle" side of the black ring. On later models, loosen the 7mm screw that anchors the spring retainer wire, approximately three turns. Using a small screwdriver, pry the end of the retainer wire that is lodged between two

teeth on the ring, up onto the ring surface, out of the way of the teeth. Early #001 meters only require loosening the straight slot retainer screw.

6) Using the screwdriver tip, at a position on the ring opposite your finger alternately press and release your finger and the screwdriver "walking" the ring counter-clockwise to unwind the spring. Release the tension slowly, one tooth at a time, to allow the engine time to react to the mixture change. Avoid any contact with the pointer as it relocates to a position in the middle of the 1mm wide "ideal mixture range" previously determined.

7) When you have reached the midpoint (whether you unwound the ring as few as five or as many as forty teeth), reposition the retainer wire between two teeth and retighten the retaining screw.

8) Now your idle should not only be at a higher rpm but should also be smoother as well. Since, however, most driving is at partial throttle it will be necessary to test your adjustment before concluding.

9) Holding the throttle lever at such a position as to maintain 3,000 rpm, once again slowly advance and release the door to locate (as you did at idle) the "ideal mixture range". If your adjustment is correct, the pointer will already be located between the low end and the midway point of this range (in which case, refer to step #11). If it is below this partial-throttle "range", you will need to return to step #4. If the pointer is above midpoint, continue with the next steps.

10) With an idea of approximately how far the pointer needs to move, loosen the 7mm screw, dislodge the retainer, and this time wind the spring (clockwise motion) with the engine idling, until the pointer has retreated the estimated distance. Rehook the retainer, tighten the screw and repeat step #9.

11) At this point you should have the spring tension correctly adjusted as per the partial throttle test in step #9. What remains is to adjust the idle CO screw for proper idle mixture.

Adjusting the Idle CO Screw:

Without fail, after every air flow meter adjustment the idle fuel mixture should also be adjusted as follows.

- 1) With the engine continuing to idle, rotate the CO screw counter-clockwise until the idle rpm drops and the engine begins to run rough (mixture too lean).
- 2) Now reverse the screw rotation (clockwise) until the screw bottoms in the bore, while counting the number of complete turns.
- 3) Ideally, the idle rpm should have "peaked" one to three turns before the screw bottomed. If this was the case, rotate the screw counter-clockwise until the idle just begins to drop, then reverse direction for one final full turn clockwise.
- 4) To test the CO for too rich a mixture, "blip" the throttle and listen to the rpm as the engine decelerates. If the rpm drops below normal idle rpm momentarily, then increases to normal, the mixture is too rich. Rotate the screw counter-clockwise in 1/2 turn increments until the idle drops gradually to normal rpm and not momentarily below.
- 5) If the final adjustment position is more than three or four turns from the bottom, this indicates that the system is adjusted too rich. Return to step #9 above.
- 6) If, however, the idle still appears to be too lean, (CO screw is bottomed) return to step #4 and double-check your air flow meter adjustment. If your adjustment is in accordance with the specifications listed, try one or more of the following:
 - a) On the right of the the throttle valve housing on the valve cover side of the common intake manifold log is a small vacuum line that runs underneath the log and out of sight. Remove the line and plug the vacuum take-off with your finger. If the idle is indeed too lean, the rpm will increase. This line activates the diaphragm in the fuel pressure regulator that lowers the fuel pressure (leans the fuel mixture) at idle only. It can therefore be plugged with a ball bearing or equivalent and reconnected to the vacuum take-off. Return to step #1.
 - b) If the idle fuel mixture is still too lean and you have double-checked your air flow meter adjustment(s), you more than likely have some significant intake leaks, and should refer to the Intake Leak Section.

IMPORTANT NOTE: We have experienced several 1978 530is that continue to run too lean despite all adjustment efforts. The solution involves a computer (brain box) alteration. See E.C.U. section for further details.

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Air Flow Meter - Engine Remounting:

- 1) Remove all excess silicone sealant from the meter, lightly apply sealant to the black plastic cap and reglue it into position.
- 2) Remount meter to bracket housing (1977 and later models) or bracket slide (1975 and 1976).
- 3) Reconnect air bellows and/or elbows and respective caps.
- 4) Remount the entire assembly to engine compartment brackets.
- 5) Retighten bellows clamp at throttle housing.
- 6) Reconnect electronic terminal to air flow meter.

ADVANTAGE OF AIR FLOW METER ADJUSTMENT OVER REPLACEMENT

As an engine ages, wear and time take their toll on connections, gaskets, and rubber or plastic parts. This wear and tear can result in a reduction in the manifold vacuum. Air flow meter recalibration can adjust the mixture to account for minor vacuum leaks. Here are some common areas for leaks:

Intake Manifold & Engine Vacuum Leaks:

See preceding section. The engine crankcase is under vacuum because the crankcase is connected to the intake manifold via the positive crankcase ventilation (PCV) system.

Blow-by:

Engine blow-by occurs when compression leaking past the rings goes into the crankcase. This additional pressure into the crankcase reduces crankcase vacuum via the breather hose which in turn reduces manifold vacuum.

Lean Mixture:

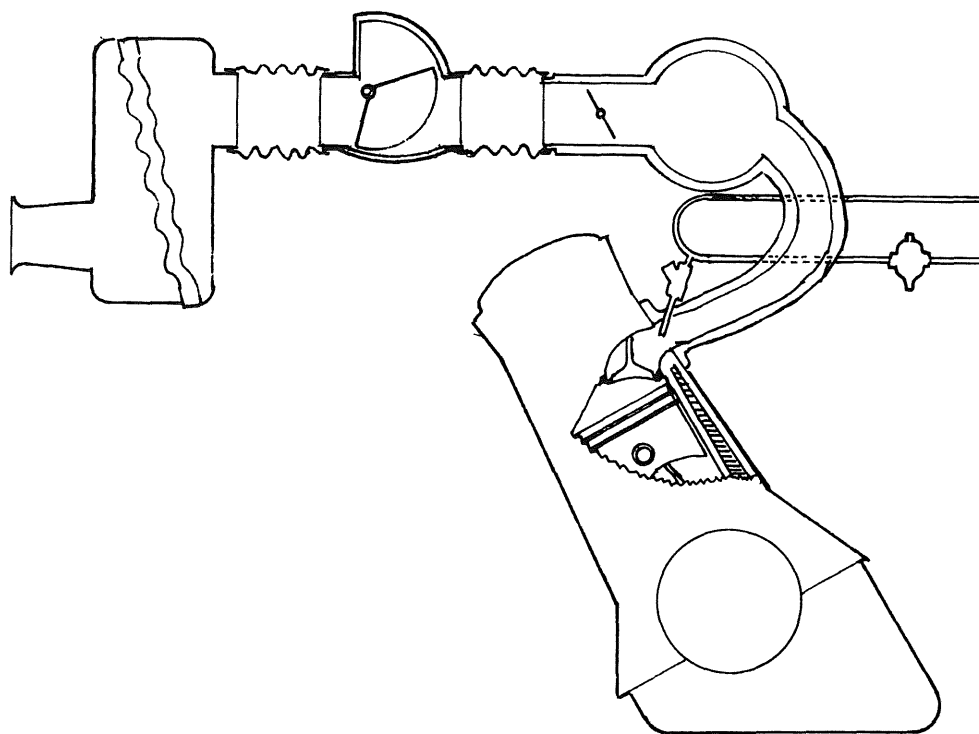
When manifold vacuum is reduced by intake manifold leaks, engine vacuum leaks, and blow-by the air flow meter door retracts and in turn leans the fuel mixture. When a car has a weak lean idle, manifold vacuum will be lowered even further. This lean mixture can cause backfiring in the intake manifold which will permanently damage the air flow meter door. As your engine ages, the air flow meter will have to be recalibrated to match the running requirements of your engine. Consider that a new air flow meter is calibrated for a new engine, e.g. one with no vacuum leaks and no blow-by, so it cannot provide an adequate mixture for an old engine.

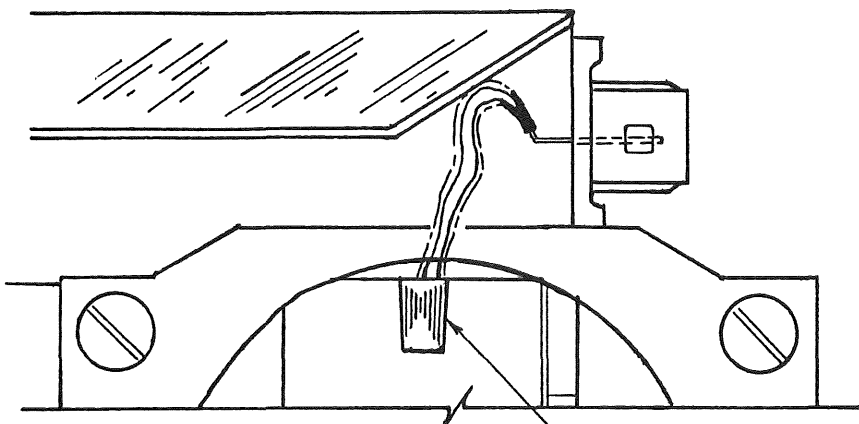
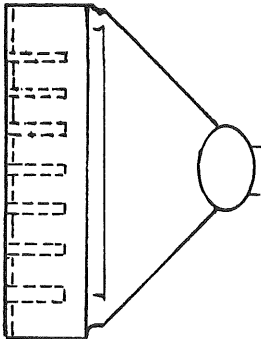
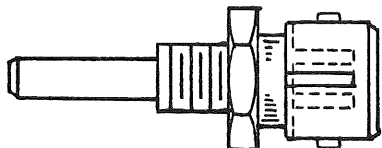
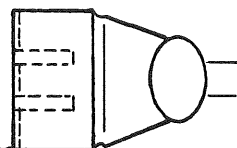
Notes of Interest:

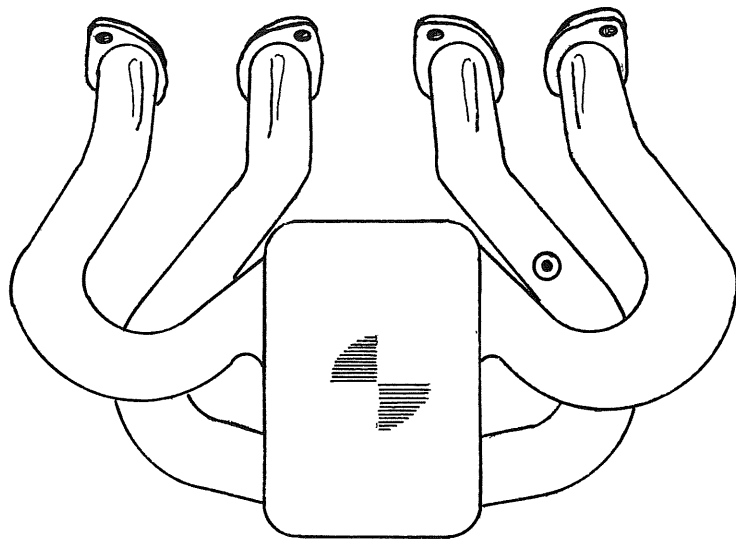
- 1) The CO adjustment screw on K-Jetronic fuel injection directly adjusts fuel delivery from idle to high rpm.
- 2) The Co adjustment screw on L-Jetronic fuel injection is an air bleed that has only a minor effect on fuel delivery at idle and has no effect at high rpm.
- 3) Recalibrating the air flow meter adjusts fuel delivery from idle to high rpm. Therefore, a L-Jetronic air flow meter adjustment is analogous to setting the CO on a K-Jetronic system.

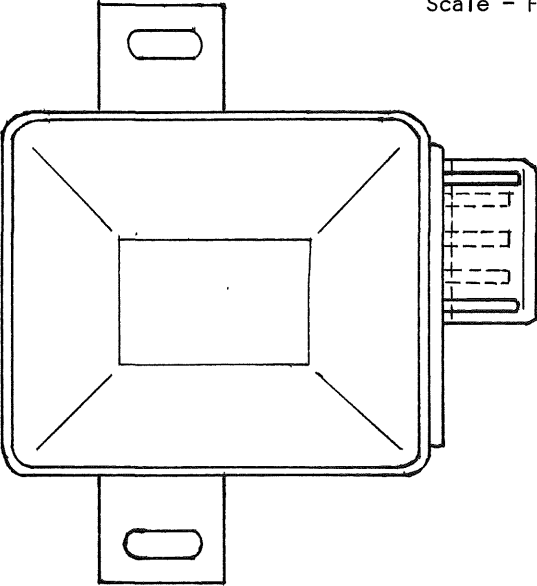
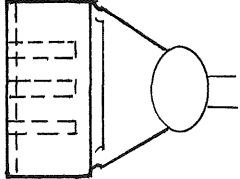
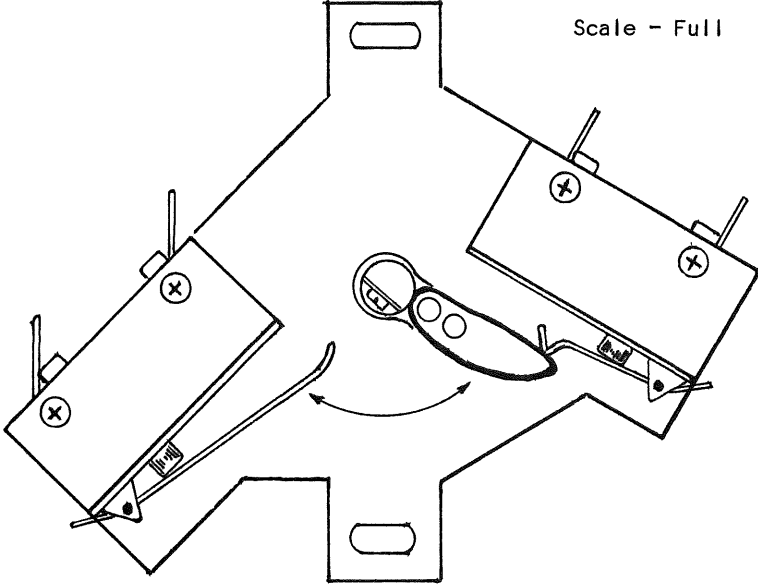
4) On a manifold vacuum guage a BMW 6 cylinder with L-Jetronic fuel injection should read 13" of vacuum. This is assuming:

- a) The engine is in a proper state of tune and is timed correctly.
- b) All major vacuum leaks have been eliminated.
- c) The spring tension on the air flow meter door is adjusted properly (very often we will use a manifold vacuum guage to set-up proper spring tension).
- d) The idle falls within the 900 to 1000 rpm range and CO is adjusted correctly.



PART		SENSOR		
AIR and COOLANT TEMPERATURE SENSORS				
ILLUSTRATION		ELECTRICAL CONNECTOR		
Scale - Full		Identification and color code		
				
Air temperature sensor		BLACK		
ILLUSTRATION		ELECTRICAL CONNECTOR		
Scale - Full		Identification and color code		
				
Coolant temperature sensor		WHITE		
PART NUMBERS		COMMENTS		
Air temperature sensor is built into the roof of the air flow box and can not be replaced.				
Coolant temperature sensor Bosch 0 280 130 023				
SPECIFICATIONS				
Temperature readings in degrees Fahrenheit and Centigrade.				
Resistance readings in OHM's.	176°F (80°C)	104°F (40°C)	68°F (20°C)	14°F (-10°C)
	250-400 Ω	900-1300 Ω	2000-3000 Ω	7000-12,000Ω



PART THROTTLE VALVE SWITCH	SENSOR
ILLUSTRATION Scale - Full 	ELECTRICAL CONNECTOR Identification and color code 
Scale - Full 	COMMENTS The later style Throttle switch uses two micro switches.
PART NUMBERS Throttle switch... 1975- 1978 ... Bosch 0 280 120 206 1979 6331 & 7331 Bosch 0 280 120 206	

THROTTLE VALVE SWITCH

Location:

Mounted to the throttle housing, on the end of the throttle shaft opposite the throttle lever is a black rectangular box with a three prong electronic terminal on it. On later models (1974-81) this combination switch was replaced by two separate microswitches mounted to a common plate.

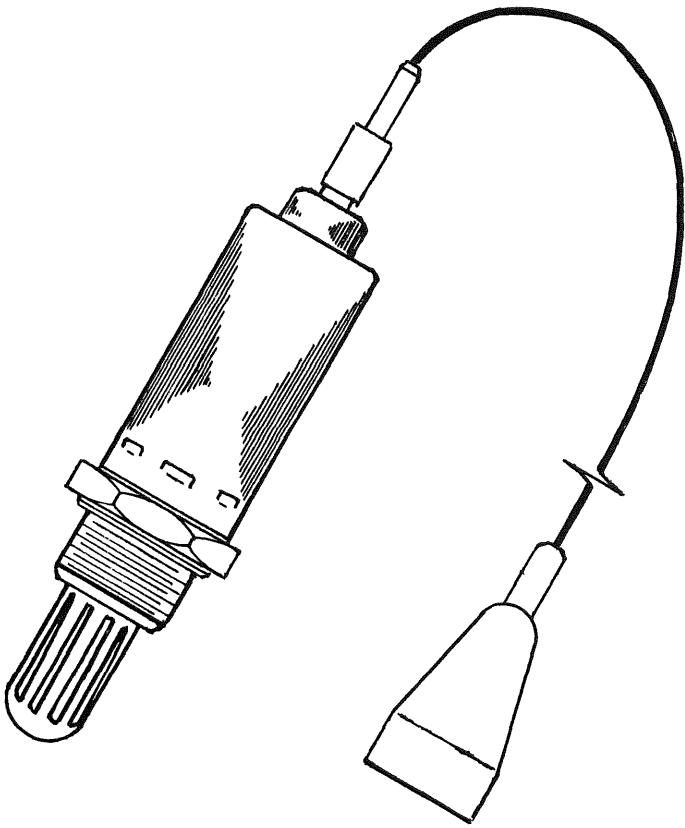
Function:

The throttle valve switch is actually a double switch. First, there is an idle switch that is activated (closed) only when the throttle is closed and whose purpose is to slightly lean the fuel mixture at idle. Immediately off idle position, this switch is deactivated (opened) and it is not until the throttle opens at least $\frac{3}{4}$ of the way that the full-load switch is activated (closed). This second switch richens the fuel mixture for maximum, full throttle acceleration.

Testing:

It would be an extremely rare instance if a throttle valve switch were defective. In any case, the idle switch has little or no effect on engine operation. It is important, however, that the full-load switch functions and this one can be easily tested.

- 1) Start the engine and let it idle until completely warmed.
- 2a) With a screwdriver, pry the four tabs of the black plastic cover off their respective mounts and slide the cover off the switch (1975-78 only).
- 2b) There is no protective cover over the throttle switches and to activate the switch, manually depress the lever (1979-81 models).
- 3) With the engine idling, activate (close) the full-load switch with your finger and listen for the rpm to increase.
- 4) If there was no rpm increase at idle, hold the throttle valve partially open (about 3,000 rpm) and again activate (close) the full-load switch. You should now observe at least a minor increase in engine rpm.
- 5) On early model switches, replace the black plastic cover making certain that the tabs are in place.

PART OXYGEN SENSOR	SENSOR
ILLUSTRATION Scale - Full 	ELECTRICAL CONNECTOR Identification and color code
PART NUMBERS Oxygen sensor..... Bosch 0 258 001 010 (Lambda probe) Bosch 0 258 001 018 Superseded to Bosch 0 258 001 032	COMMENTS

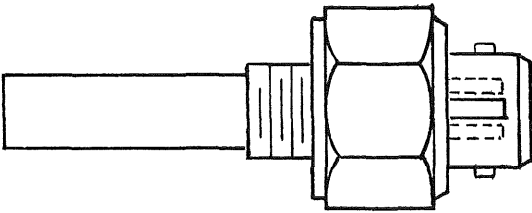
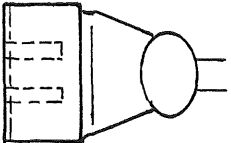
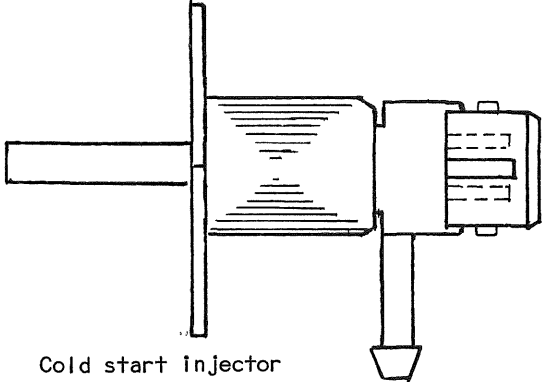
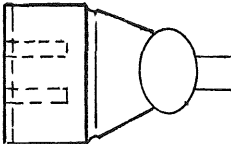
**OXYGEN SENSOR
(Lambda Probe)
Unleaded Fuel Models Only**

Superseding the belt driven smog pumps, EGR systems and thermal reactors is the catalytic converter/oxygen sensor emissions system. Located in the down-pipe just below the exhaust manifold, the oxygen sensor evaluates the exhaust gases and then relays this information (via a "brain box") to the frequency valve at the fuel distributor. The sole purpose of the oxygen sensor/brain box/frequency valve network is to guarantee a near perfect fuel mixture (14.7:1 air to fuel ratio) allowing the catalytic converter to work at its utmost efficiency.

At regular 30,000 mile intervals, your lambda light will remind you that your sensor (in accordance with factory instructions) must be replaced. Actually the oxygen sensor can last as long as 45,000 miles and regardless of what the light tells you, the behavior of the engine will indicate the exact moment the sensor fails.

When the probe finally expires, it automatically gives such a reading as to cause the fuel mixture to become too rich at idle (engine at operating temperature). This causes the idle to oscillate up and down as well as a drop in fuel economy. To verify, unplug the sensor at the connection of the green and black wires. If the idle stabilizes, your only alternative at this point is replacement.

To replace, jack the car up in front and secure it well. The probe is in plain sight on the exhaust downpipe. Using a 22mm wrench, (some companies sell a special socket), loosen and remove the probe. Now follow the thin black wire up to the connection mount where it joins with a green wire, and simply pull the connection apart. Put anti-seize compound on the threads of the new probe, and tighten enough to crush the sealing ring to avoid exhaust leaks. To finish up, run the probe wire back to the green wire and connect them.

PART THERMO-TIME SWITCH and COLD START INJECTOR	SENSOR
ILLUSTRATION Scale - Full  Thermo-time Switch	ELECTRICAL CONNECTOR Identification and color code  BROWN
ILLUSTRATION Scale - Full  Cold start injector	 BLUE
PART NUMBERS Thermo-time switch..... Bosch 0 280 130 214 0 280 130 219 Cold start injector..... Bosch 0 280 170 032	COMMENTS
SPECIFICATIONS Thermo-time switch operating time in seconds vs temperature. 8 seconds -4°F (-20°C) 0 seconds 59°F (45°C)	

THERMO-TIME SWITCH AND COLD START INJECTOR

Centrally located atop the intake manifold is a small blue projection with both a fuel line and an electrical terminal attached to it, called the cold start injector. Mounted on the coolant-junction housing (the part of the engine to which the upper radiator hose is attached) is an oversized temperature sensor/switch, with a two-wire electronic terminal. On 1975-80 six cylinder models, the sensor/switch is located in a coolant junction below the intake manifold, between runners #3 and #4. When cranking the engine this sensor evaluates the coolant temperature and, depending on how much below 50°F the coolant is, allows from 0 to 8 seconds of current to pass to the cold start injector. The current in turn activates the solenoid that opens the injector allowing pressurized fuel to enter the intake manifold. The colder the engine, the more crucial this initial charge of fuel. Therefore, these two mechanisms, if either malfunctions, cause difficult cold starting.

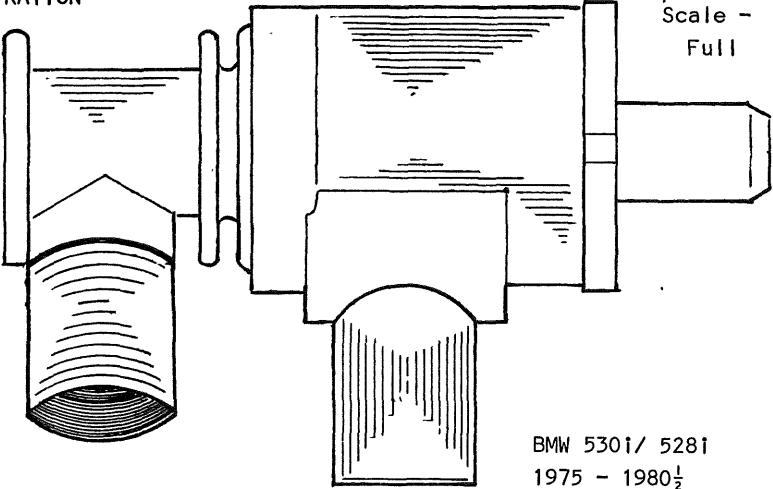
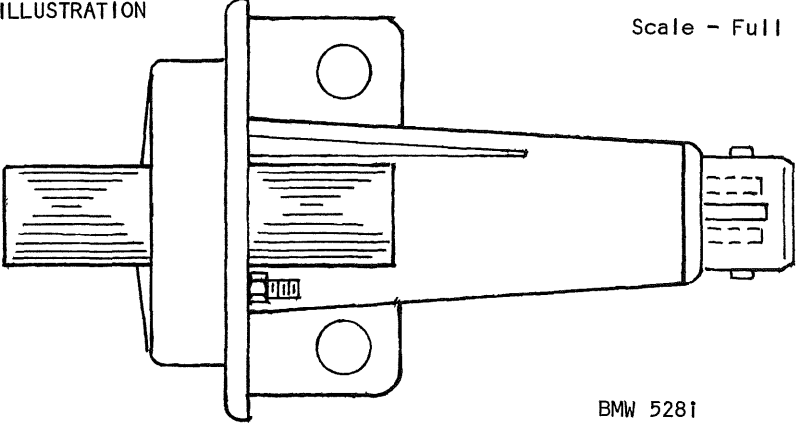
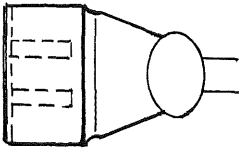
Trouble-Shooting (Cold Engine Only):

- 1) Before starting the engine, loosen the two 10mm nuts and remove the cold start injector with the fuel line and electronic connection in tact.
- 2) Find a suitable container to aim the injector into so that, when activated, fuel does not spray where it might ignite. Detach the primary lead from the coil to prevent the engine from starting.
- 3) Turn the key to the cranking position just long enough to verify that there is a conic spray of fuel from the injector, and then turn the ignition off. The spray of fuel should be simultaneous with the cranking of the starter. If this results, your cold start problem lies elsewhere. If there is no spray of fuel, continue.
- 4) Before any further electrical tests, detach the fuel line to the cold start injector (note the two sealing washers on 320i's), aim it into the container and then activate the starter. There should be a steady flow of fuel from the line. If not, refer to the section on "Fuel Pump, Relay and Fuse Trouble-shooting". If there is fuel flow, continue with the procedure.
- 5) Disconnect the plug-in terminal of the cold start valve and set up your test light with the probe on one of the two plug terminals. Activate the starter, testing for current first on one wire and then the other. One of the

terminals should have current when the starter is engaged. If so, the cold start injector needs replacing. If there is no current at either terminal, continue.

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6) Disconnect the plug-in terminal of the thermo-time switch and test both terminals for current as in step 5. If there is current at either terminal while the starter is engaged, the thermo-time switch is defective. If not, check terminal "50" (the smallest of the three on the starter) with the test light for current while the starter is engaged and to ensure that the attached wire is making good contact (see injection wiring diagram).

PART AUXILIARY AIR VALVE	SENSOR
ILLUSTRATION  Scale - Full BMW 530i/ 528i 1975 - 1980$\frac{1}{2}$	ELECTRICAL CONNECTOR Identification and color code
ILLUSTRATION  Scale - Full BMW 528i 1980$\frac{1}{2}$ - on	 BLACK
PART NUMBERS Auxiliary air valve... 1975 - 1979 Bosch 0 280 140 018 1979 - 1980$\frac{1}{2}$ Bosch 0 280 140 039 1980$\frac{1}{2}$ - on Bosch 0 280 140 124	COMMENTS On 528i from 1980$\frac{1}{2}$ the auxiliary air valve is adjustable.

Location:

The auxiliary air valve for all five, six and seven series cars through 1980 can be found low and near the center of the engine block (on the driver's side) close to the oil dipstick, directly below the #3 intake runner. From 1981 on, BMW updated with a valve similar in appearance and location to those on 320i's (bolted to the valve cover).

Function:

In order for the engine to idle by itself (i.e. with the throttle closed) it is necessary to allow a certain amount of air to bypass the throttle and this idle air is governed by the idle air bypass screw. When the ambient air temperature drops below 68°F, the fuel mixture must be richened to provide adequate vaporization for combustion. However, to maintain a smooth and consistent idle, additional air must bypass the throttle valve. Augmenting the volume of idle air, during "cold" engine conditions, is the responsibility of the auxiliary air valve.

Symptoms/Adjustments (1975 through early 1980 models):**I. Low Rpm Idle (Cold Engine)**

Engine idle at operating temperature should be at or near 1000 rpm. If it is not, follow the Co and idle bypass adjustment procedures (see air flow meter section). At temperatures below 68°F, a cold engine will initially idle between 1400 and 2000 rpm, and as the engine warms will gradually return to 1000 (never below normal warm engine idle). If the engine idle is consistently below 1000 rpm during all cold start conditions and yet the engine revs with immediate response (with out being hesitant or "labored"), your auxiliary air valve is not opening enough to allow sufficient bypass air for a stronger, higher rpm idle. Unfortunately, the early valve is non-adjustable but to determine whether or not the valve functions perform the following procedures:

- 1) With the cold engine idling, loosen the clamp on the black hose connected to the upper rear take-off on the throttle housing.
- 2) In one swift motion, remove the hose and block the exposed outlet on the housing with one thumb, while testing the hose for suction with the other.

- 3) The vacuum should be considerable, and if it is minimal or there is no suction at all, the valve will have to be replaced.

II. High Rpm Idle (Warm Engine)

- 1) Occasionally the auxiliary air valve will remain in the open position allowing an excessive amount of air to bypass the throttle.

- a) Loosen the clamp on the black hose connected to the upper, rear take-off on the throttle housing.

- b) With the cold engine idling, in one swift motion, remove the hose and block the exposed outlet on the housing with one thumb, while testing the hose for suction with the other.

- c) If there is any suction while the engine is at operating temperature, the valve must be replaced.

- 2) Deceleration Valve - attached to the back of the intake manifold, hanging over the valve cover, is a bell shaped metal component. The smallest vacuum line attached to the end of the valve, controls the amount of bypass air that flows through the two larger hoses. If the idle "hangs-up" or delays returning to idle rpm when decelerating, the valve needs adjusting. Loosen the lock nut and turn the bolt in or out, to set the idle behavior correctly. If the valve will not adjust correctly, simply plug the small vacuum line and the engine will return to normal idle immediately after revving.

- 3) Once in a while the throttle shaft itself will become stiff enough that it will not totally return to idle position. Any spray lubricant (e.g. WD-40, ZEP-45) will free the mechanism.

- 4) All six cylinder cars are equipped with a combination vacuum retard/centrifugal advance distributor (later models also have a vacuum advance). The retard lines draws vacuum from underneath the throttle housing next to the "elbow" hose from the valve cover. Test the functioning of the vacuum diaphragm, with the engine idling, by disconnecting the attached line. If the idle rpm increases, all is well. However, if there is no rpm increase:

- a) Inspect the vacuum line itself for leaks.

b) Remove the distributor cap and suck on the retard line. The retard diaphragm should rotate the points plate. If you cannot create a vacuum in the line, the diaphragm is leaking and must be replaced.

c) Finally, if you can simulate a vacuum in the line and the points plate does not rotate, it is frozen and will have to be lubed, so it will rotate freely.

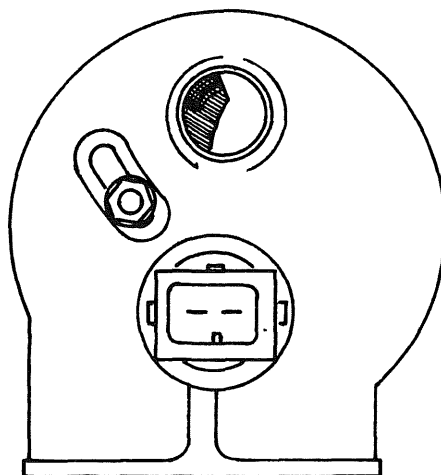
5) If a high warm engine idle still persists, refer to the section concerning intake leaks.

Symptoms/Adjustments (late 1980 models and later):

I. Low Rpm Idle (Cold Engine)

Engine idle at operating temperature should be at or near 1000 rpm (if not, refer to the air flow meter section). At temperatures below 68°F, a "cold" engine will initially idle between 1200 and 1400 rpm, and will gradually return to normal as the engine approaches operating temperature. If the cold engine idle is always at or below 1000 rpm during all cold-start conditions and yet the engine revs with immediate throttle response, without hesitation, your auxiliary air valve is not opening enough to allow sufficient bypass air for a stronger, higher rpm idle. To determine whether or not the valve functions:

- 1) Loosen the 7mm nut on the front side of the large center disc to which both hoses clamp.
- 2) Using the long tubular part of the housing as a fulcrum and a medium screwdriver as a lever, pry the nut towards the outside of the disc.



- 3) Start the car (engine must be "cold") and immediately turn it off when the initial idle rpm reading has been made. It should be higher than it was prior to adjusting the valve.
- 4) If the rpm is too high (over 1400) start the engine, move the nut back towards its original position until the rpm is correct; retighten.
- 5) If there is no change in rpm or the nut is already out to its limit, slide it back towards the center of the disc until it stops. Restart the engine with the expectation of observing an even lower idle rpm that was observed prior to adjusting.
- 6) If the idle is indeed lower, quickly reset the idle bypass screw (on the side of the throttle housing) then shut off the engine to cool. Return to step 2 and repeat the necessary procedures.
- 7) If there is no change in idle rpm regardless of the location of the adjusting nut, the valve will have to be replaced.

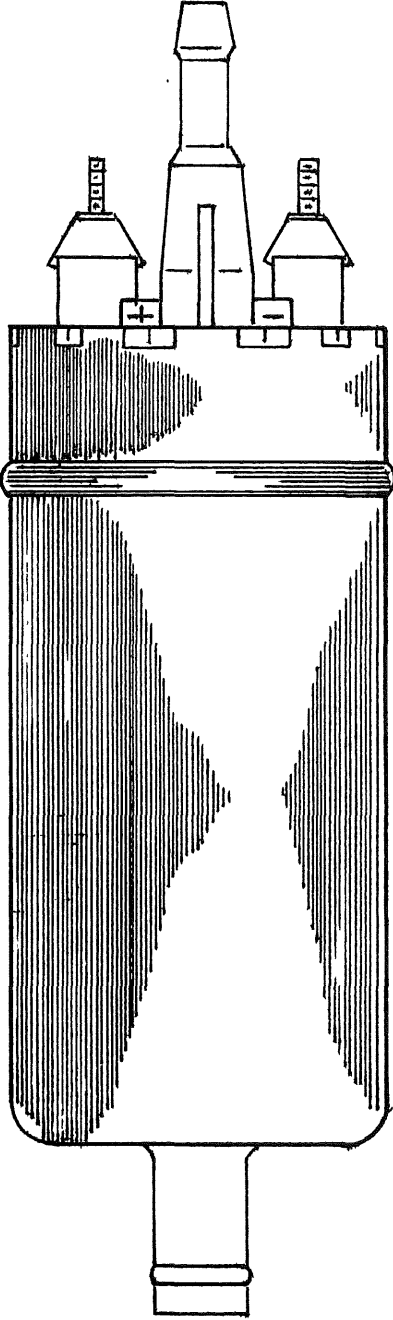
II. High Rpm Idle (Warm Engine)

There are several possible reasons why an engine refuses to idle down to its normal operating temperature rpm:

- 1) Occasionally the auxiliary air valve will remain in the "open" position allowing an excessive amount of air to bypass the throttle valve.
 - a) Loosen the air hose from the valve at the end that attached to the intake manifold (directly under the cold start injector).
 - b) With the engine idling, in one swift motion, remove the hose and block the exposed outlet on the housing with one thumb, while testing the hose for suction with the other.
 - c) If there is noticeable suction and the engine is at operating temperature, the auxiliary air valve is defective.
 - d) If there is a slight amount of suction, loosen the 7mm nut on the valve and slide it towards the tubular part of the housing. It

might be possible to close the valve sufficiently to eliminate the unwanted air flow. If not, it will need to be replaced.

- 2) Occasionally the throttle shaft itself will become stiff enough that it will not totally return to idle position. Any spray lubricant (e.g. WD-40, ZEP-45) will free the mechanism.
- 3) Throttle valve sticking (see early models, above).
- 4) If a high warm engine idle still persists, refer to the section concerning intake leaks.

PART FUEL PUMP	FUEL SYSTEM
ILLUSTRATION 	ELECTRICAL CONNECTOR Identification and color code COMMENTS The positive terminal uses a 7mm nut and the negative terminal uses an 8mm nut on the fuel pump.
PART NUMBERS Fuel pump... 1975-1976 Bosch GFP 251 1977- on Bosch GFP 263	

FUEL PUMP, RELAY and FUSE TROUBLE-SHOOTING

Testing:

Fuel pump mechanical or electrical failures are infrequent on six cylinder models. Unlike the four cylinder models, the fuses are more protected from corrosion by the elements, the relay is more dependable and the fuel pump itself has exceptional longevity. For trouble-shooting purposes, however, pump operation is easily tested and therefore easily eliminated as a possible cause, by following these steps:

- 1) Loosen the hose clamps and remove the intake air "elbow" (or bellows for 1975 and 1976 models);
- 2) Prop open the spring-loaded door inside the air flow meter with a screwdriver;
- 3) Turn the ignition to the "on" position.

If you hear a relatively quiet and consistent "buzzing" from underneath the car just inside of the passenger's side rear wheel, your pump is operational. If you hear nothing, continue with this section.

Fuel Pump Fuse:

The fuse box is located in the engine compartment on top of the driver's fender above and behind the battery. The fuse in the right front corner of the box is the one for the fuel pump circuit. Replace the fuse with a new one of the same amperage. Even if it is not blown, any corrosion on the exposed metal strip will cause current resistance. Repeat the testing steps listed above. If the pump does not operate, use a test light to verify current at the fuse.

Fuel Pump Relay:

If you have current through the fuse but still no pump operation, possibly the relay is at fault. The pump relay is 1/2 of a combination pump/injection relay located either on the firewall or on the relay mount bracket next to the coolant overflow tank. It is the largest relay with two multi-wire plastic connectors, one with several different colored wires and the other with all white wires.

Remove the colored-wire connector from the relay and, with a suitable jump wire, close the circuit between the red wire and the wire 180° from it. With the ignition on you should hear the pump operate. If it does, the relay must be replaced. If not, reconnect the wires to the relay and continue.

Fuel Pump:

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The electrical fuel pump is located above and to the passenger side of the differential, underneath the car. Add the three testing steps above to the following:

- 4) Remove the two protective rubber boots from the pump terminals,
- 5) Using the negative post (the larger one with the 8mm nut) as ground, test the positive post (the smaller one with the 7mm nut) for current.

If your test light shows current but the pump does not operate, the pump will have to be replaced. If there is no current present, refer to the factory electrical diagram.

Fuel Pump Check Valve:

Although the fuel pump is equipped with a check valve, whether or not the valve functions has virtually no effect on the operation of the engine. Unlike the K-Jetronic system that requires a 1.8 bar (25 psi) residual pressure to facilitate warm engine starting, the L-Jetronic system requires no residual pressure at any time.

BLOCKED FUEL FILTER

A fuel filter becomes blocked when foreign matter (rust) leaves the fuel tank and is drawn into the fuel filter. As fuel moves through the filter, the particles of foreign matter are deposited on the filter element and cause the fuel flow to be restricted.

Symptoms of a Blocked Fuel Filter:

The car will run as usual for a distance and then begin missing (fuel starvation) and losing power. If you stop the car engine may stall. 10-20 minutes after stalling, the engine will start immediately and run normally. Again after driving a shorter distance, these symptoms reoccur. This pattern occurs because each time you shut off the engine the particles of foreign matter dislodge from the filter element and the fuel restriction is temporarily removed.

Eliminating the Blocked Fuel Filter:

Most problems with blocked fuel filters can be avoided by preventive maintenance. This means changing the fuel filter every 10,000 miles and buying fuel at stations that have high fuel turnover and use fiberglass underground storage tanks.

If you suspect a blocked fuel filter, do the following:

- 1) Remove the fuel filter from the car for inspection. On pre-1977 BMW's, the fuel filter will be on the driver's side of the engine compartment underneath the coolant expansion tank. On 1977 or later cars it will be under the car on the passenger's side of the differential.
- 2) Shake the fuel and foreign matter (rust) out of the inlet side of the fuel filter into your hand. If there is a significant deposit of particles, then there is a good chance the fuel filter is the problem.
- 3) Replace the fuel filter. Even if the fuel filter appears to be free of deposits, if it has not been replaced recently, replace it any way.

When enough water infiltrates the fuel supply it will cause a restriction in the fuel delivery. Once pumped into your fuel tank NOTHING can remove the water short of draining the fuel tank. No form of alcohol or fuel additives will allow water to pass through the system. We have seen fuel injectors needlessly replaced because of this problem.

Symptoms of Water in the Fuel:

The car will intermittently miss and in severe cases will violently "buck" as you are driving.

Removing the Water From the Fuel:

TO REMOVE WATER FROM THE FUEL YOU MUST DRAIN THE FUEL TANK! The easiest way to drain the fuel tank is to remove the fuel line that connects to the cold start injector and attach a longer length of fuel line (6 or more feet). Run the fuel line into a suitable fuel container. Remove the rubber bellows from the air filter housing to the air flow box and prop open the air flow meter door with a screw driver. This will allow the fuel pump to activate when the ignition is turned on. Let the fuel pump run until the tank is empty, then pour in another gallon of uncontaminated gas and drain it as well. Before you fill the tank with fresh fuel, you need to replace the fuel filter. When water enters a fuel filter it swells the element causing a fuel restriction. Lastly, remove the screwdriver from the air flow meter door, replace the boot, reconnect the cold start injector line, and fill up the car with fresh fuel. It may take 15-20 seconds for it to start because the fuel system will need to purge itself of air.

Vapor lock occurs when the gas in a fuel line changes from a liquid to a vapor. When this happens a vapor pocket is formed and fuel becomes blocked. Usually, vapor locking is not a problem until temperatures hit about 100°F (38°C) or more.

Symptoms of Vapor Lock:

The car will run fine for a distance and then the engine will start to cut out (fuel starvation) and loose power. If you come to a stop, the car may stall. After letting the car sit for 10-20 minutes, it will start up and run normally again. This time after driving a shorter distance the car will start another similar episode. The reason for this is simple; each time you shut off the car the fuel cools off and the gas vapor returns to a liquid state.

Eliminating Vapor Lock:

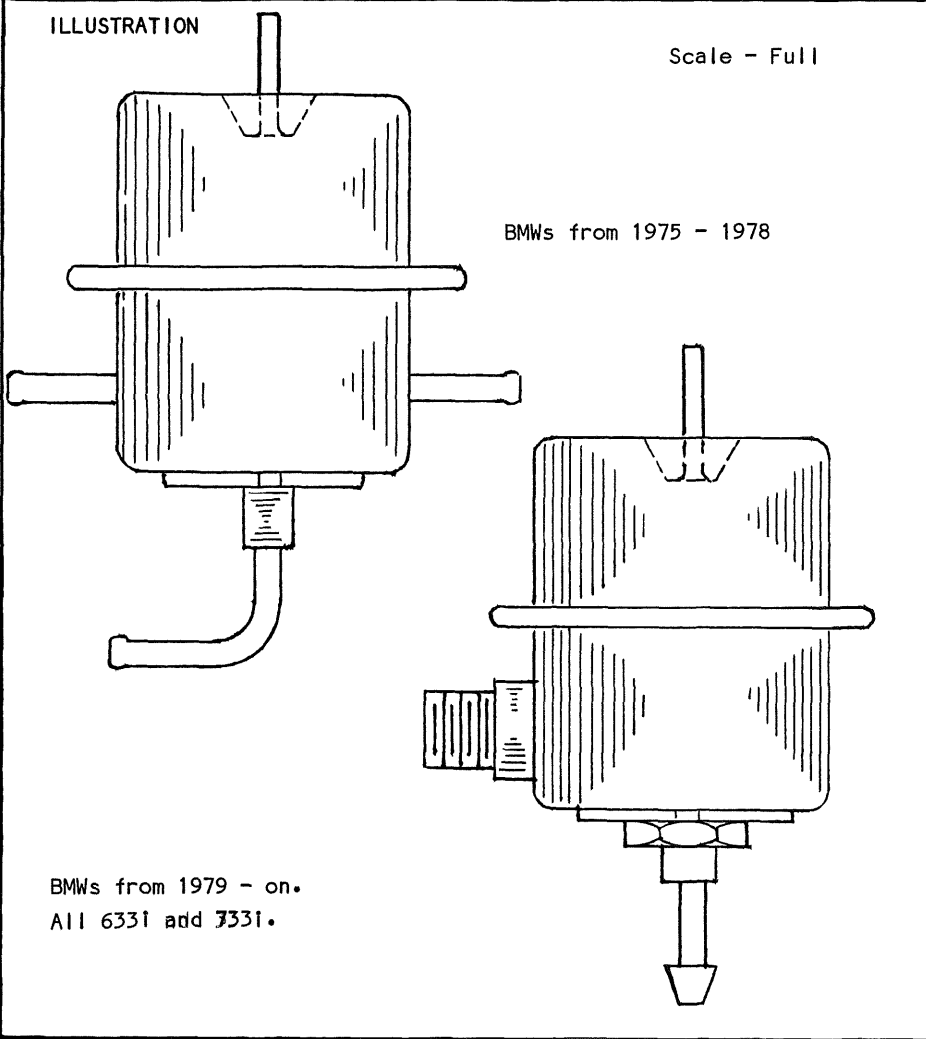
In order to eliminate vapor lock the fuel must be cooled. Fuel picks up heat from one of the following:

- 1) High under-the-hood temperatures created by the engine and air conditioning.
- 2) The gas tank absorbs heat from the hot pavement.
- 3) Fuel is heated by the electric fuel pump.

In an emergency, the simplest remedy is to allow the heat to escape out of the gas tank by removing the gas cap. On cars that use unleaded gas, you will also need to prop open the fuel restrictor flap with a screw driver. If the tank is over half-full, be cautious of spillage while driving.

If there are only a few days of the year when the temperature exceeds 100°F (38°C), try one or more of the following:

- 1) Wrap the fuel lines in the engine compartment with aluminum foil. This will reflect the heat off the fuel lines.
- 2) Paint the bottom of the gas tank silver or white.
- 3) Change fuel pumps. The fuel pump could be weak or have high internal resistance.
- 4) Integrate a fuel cooler (e.g. a small automatic transmission cooler).

PART FUEL PRESSURE REGULATOR	FUEL SYSTEM
ILLUSTRATION Scale - Full  BMW's from 1975 - 1978 BMW's from 1979 - on. All 633i add 733i.	ELECTRICAL CONNECTOR Identification and color code
PART NUMBERS Fuel pressure regulator..... Bosch 0 280 160 206 1975 - 1978 1979 - on / all 633i and 733i..... Bosch 0 280 160 014	COMMENTS
SPECIFICATIONS Fuel pressure on L-Jetronic fuel injection should be... 35.5# ±2# (2.5 bars ±.2 bars)	

Location:

The fuel pressure regulator on 530is is located under the center of the intake manifold log. It is just behind the EGR valve between #3 and #4 intake runners. On 528is the regulator is on the end of the fuel injector supply line, just ahead of the #1 intake runner and above the water pump.

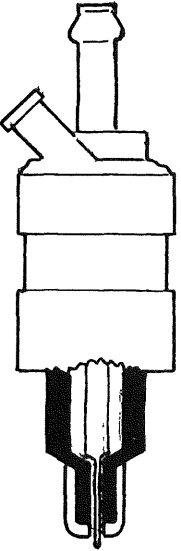
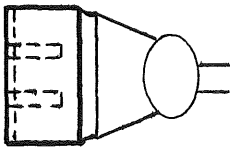
Function:

The fuel pressure regulator maintains the fuel line pressure at a constant 2.5 bars $\pm$ 0.2 bar (35.5 psi $\pm$ 2 psi).

Symptoms/Testing:

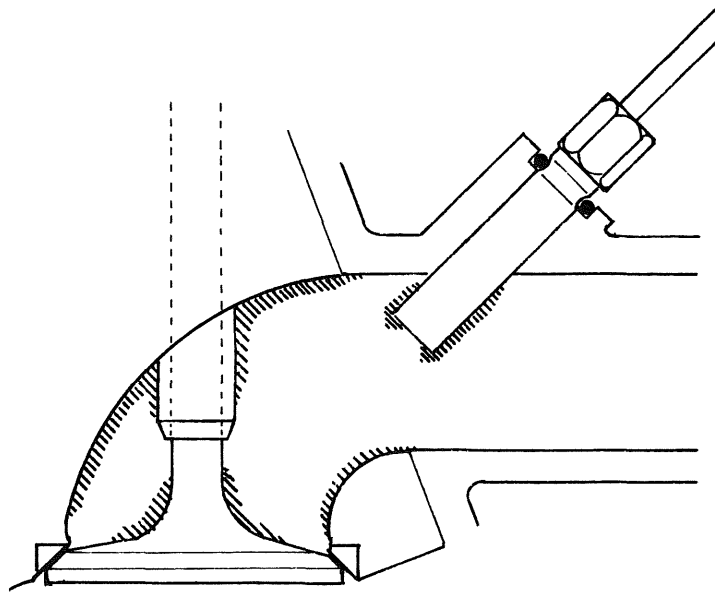
Regulator failures usually result in lowered line pressure and thus cause the fuel injection system delivery rate to drop. The results will be heavy backfiring in the intake manifold, severe lack of power and overall poor performance. Although rarely the case, the regulator can cause excessively high fuel pressure (up to 75 psi). An abnormally loud and "labored" operating noise, coupled with rough idling and constant dying are typical symptoms.

To test the fuel pressure regulator, disconnect the cold start injector line at the injector and connect a pressure gauge capable of measuring 3.0 bars (45 psi). A compression gauge with the rubber tip and check valve removed will suffice. Turn the ignition switch to the "on" position and prop open the air flow meter door with a screwdriver. Start the engine and let it idle. If you listen under the right rear corner of the car, just behind the wheel, you should hear the fuel pump operate. Check the pressure reading of the gauge - it should read between 2.3 and 2.7 bars (32.5 and 38.5 psi). If the fuel pressure is out of specification and the pump is operating, replace the fuel pressure regulator. Usually the hoses that connect to the regulator will be stiff and dry rotted and this would be an opportune time to replace all the fuel lines in the supply loop (see 530i Fuel Line Loop Repair section).

PART FUEL INJECTOR	FUEL SYSTEM
ILLUSTRATION 	ELECTRICAL CONNECTOR Identification and color code  GRAY
PART NUMBERS Fuel injector... 1975-1978 530i and all 3.0 litre engines Bosch 0 280 150 151 Fuel injector... 1979-1981 528i and all 3.3 litre engines Bosch 0 280 150 152	COMMENTS

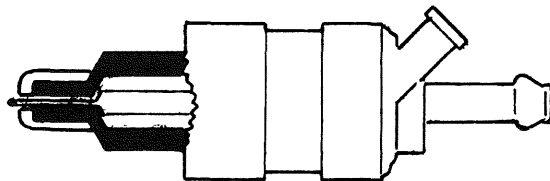
Why L-Jetronic Injectors Do Not Fail:

If you ever pull the valves out of a cylinder head you will notice that the intake port and valve will have a heavy deposit of soft carbon. Looking at the valve seat and valve face you will notice that both surfaces are free of carbon. The constant opening and closing of the valve against the seat causes the two surfaces to stay clean.



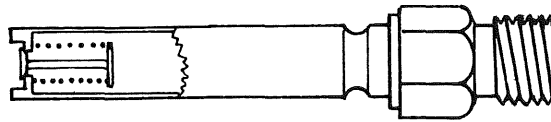
▨ = carbon deposits

L-Jetronic injectors open and close electromagnetically, triggered by the ignition points. This opening and closing action of the injector needle against its seat causes the needle and seat to remain carbon free.



Now, for the sake of argument, imagine what would happen if the intake valve remained open, constantly. Carbon would soon collect on the valve seat and valve face. Causing the port to plug and the valve and seat not to mate perfectly.

K-Jetronic injectors open when the fuel line pressure exceeds 3.5 bars (50 psi). Since the operating pressure of this system is about 5 bars, the fuel injectors are open constantly. This results in an accumulation of carbon between the needle and the seat. That restricts fuel flow. Fuel restriction becomes apparent during high fuel demands; such as cold engine operation and high rpm acceleration. Carbon on the needle and seat can also cause the injector to leak when the deposits prevent the needle from seating.



530i FUEL LOOP LINE REPAIR

530is from 1975-78 may develop fuel leaks at the short fuel lines which supply the injectors from the fuel loop. The symptoms which point to this source are: fuel odor only upon starting cold engine, fuel odor strongest under hood.

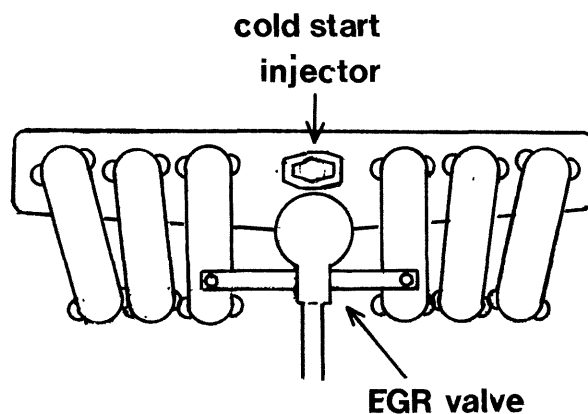
These leaks are caused by a deterioration in the old fuel hose which causes the hose to swell when hot and shrink when cold, allowing fuel to leak around the crimped-on fittings at the injectors.

To repair leaks in the fuel loop supply lines it is necessary to remove the loop and injectors from the vehicle, replace the old hose with modern fuel injection line (with external molded ribs running parallel to the fuel line; do not use line with an externally braided cover), and replace the crimped fittings with quality stainless steel hose clamps.

The procedure is as follows:

I. Remove Intake Manifold Runners and Injectors:

A. From the driver's side of the engine compartment, remove the air hose, fuel line and electrical connector from the cold start injector at the center of the manifold. (Use a small screwdriver or pick to pry away the locking spring on the electrical connector.)



B. Remove EGR valve from manifold (just below cold start injector) by:

- 1) Remove bolts from bracket between intake runners #3 & #4.
- 2) Tap valve out of manifold, towards driver's side of vehicle.
- 3) Remove bolts and bracket between intake runners #2 & #3, if present.

C. Remove fuel hoses from metal lines on lower left chassis rail:

- 1) Fuel supply line, forward on chassis rail, below coolant tank.
- 2) Fuel return line, rearward on chassis rail, below master cylinder, connects to pressure regulator.

D. To facilitate access, disconnect vacuum lines from manifold plenum, typically coded:

- 1) Blue to EGR valve
- 2) Red to EGR valve
- 3) Red to throttle
- 4) Large black brake booster line
- 5) Label lines as necessary.

E. Label each intake runner with its cylinder number; remove four nuts and washers for each; withdraw and set aside all runners; take care not to damage gaskets.

F. Disconnect electrical connectors from each injector.

- 1) If necessary, tag and number each connector first;
- 2) Pry away spring clip before pulling connector.

G. Remove the two bolts which retain each injector. Take care not to lose paper shims and gaskets.

H. Remove loop complete with all injectors, pressure regulator, supply and return lines attached.

I. Undo clamps retaining injector supply lines to loop and remove each injector with its line. Note how each injectors electrical connector is oriented.

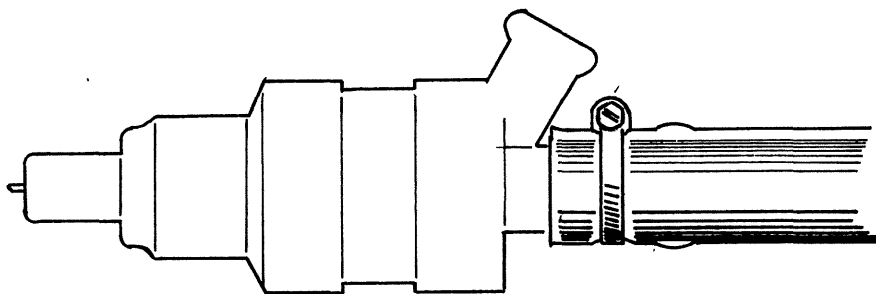
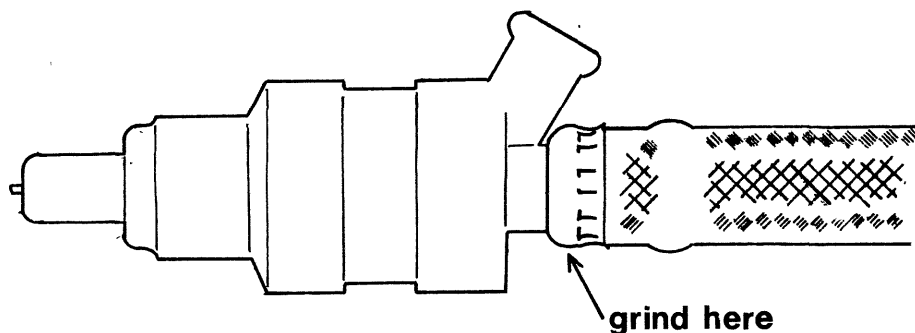
J. Undo all other clamps, set hoses aside to use for measuring new fuel line. Label as necessary.

II. Replace Supply Line to Each Injector:

A. Source a high quality fuel injection line with ribs running parallel to line. Avoid externally braided line. You will need about two meters (6 feet).

B. Source high quality stainless steel hose clamps, size 10-16mm. You will need at least 22 clamps.

C. Grind or saw fuel line crimp at injector inlet until crimp and hose can be pulled off. Do not cut into plastic injector.



D. Measure, cut and install new ribbed line using new clamps. Assemble complete loop with all injectors, pressure regulator and other lines attached. Observe orientation of electrical connectors on injectors. Tighten clamps securely - avoid cutting hose.

E. Install injector loop and manifold runners. In the interest of brevity, installation can be said to be the reverse of removal (see Section I), with the following notes:

- 1) Observe carefully the placement of the paper shims and gaskets for injectors.
- 2) Torque on injector retaining bolts not to exceed 0.8 kg/m (6 ft/lb.).
- 3) Intake manifold runner gaskets may be re-used if undamaged. Replace any questionable gaskets (see section on vacuum leaks).
- 4) Fuel hoses connecting to metal lines on chassis rail:
 - a) Forward line connects directly to loop.
 - b) Rearward line connects to pressure regulator.
- 5) Carefully tap EGR valve back into place - do not damage O-ring.

Modified Injection Computers

For reasons unknown to us at this time, several 1978 530is have come to us with a special problem. As is the case with all engines equipped with L-Jetronic systems, over time the fuel mixture gradually leans to the point of requiring an air flow meter adjustment to recover lost performance. With some models of this year however, the leaning is so severe that several component adjustments are necessary to even approximate the proper air-to-fuel ratio that the engine demands.

Presently under investigation is a computer circuitry that will allow these exceptionally lean six cylinder models to return to status quo with only minor air flow meter recalibrations. Even more encouraging, in the last 1 1/2 years of research, has been the increased throttle response and overall improved performance of our first few prototypes. The future looks favorable for the introduction of a modified computer, which will require simple connection and may unleash as much as twenty percent more horsepower!

THE "ULTIMATE TRANSMISSION"

By Jim C. Rowe, Jim Blanton & Paul Williamsen

Metric Mechanic, an independent shop in Kansas City, Missouri specializing in BMW repair, has developed a proprietary process for rebuilding BMW transmissions which directly addresses the two problem areas of BMW transmissions, layshaft bearing failure and short synchronizer life. Based on our customers' experiences over the last four years and our own involvement with racing a BMW 2002tii in SCCA Solo II and BMWCCA Oktoberfest autocrosses, we feel we have developed the "Ultimate Transmission". In terms of synchronizer and bearing life its longevity is unmatched. The objective of this report is to show the specifications and performance differences between the Ultimate Transmission and a conventional rebuild.

STATING THE PROBLEM

BMW transmissions are quite strong for the most part, but they do have two weak areas: 1) Layshaft bearing failures and 2) short synchronizer life. When a layshaft bearing fails, it can become quite serious; the bearing can come apart and quickly destroy the transmission. Synchronizer failures make the transmission miserable to shift. By solving these two shortcomings we have produced a very strong, long lasting transmission.

LAYSHAFT BEARINGS

Layshaft load occurs in both the radial (across-the-shaft) and axial (along-the-shaft) planes. The OEM ball bearing has a moderate load rating but most of its load capacity is in the radial plane. The roller bearing used in later model transmissions is stronger, but only in the radial plane: it is not designed for axial loads. The tapered roller bearing, however, can accept virtually equal radial and axial loads. The critical benefit of the tapered roller bearing is its high load rating. The BMW transmission case imposes a tight limit on the size of bearings, and for a given size a tapered roller is much stronger than a comparably sized roller or ball bearing.

As an example of how strong our layshaft bearing is, compare it to the output shaft bearing as used in the OEM transmission. In our 9 years of rebuilding BMW transmissions we have never seen an output bearing fail. We believe that one of the reasons for the tremendous durability of the Ultimate Transmission is the 3000 lb. margin of safety provided by the use of tapered roller layshaft bearings.



BMW MANUAL TRANSMISSION 2 YEAR WARRANTY

4 Speeds — \$695
5 Speeds — \$895

Price with exchange of a REBUILDABLE TRANSMISSION applies to all 4 and 6 cylinder models using Borg Warner synchronizers. Must send a similar core.

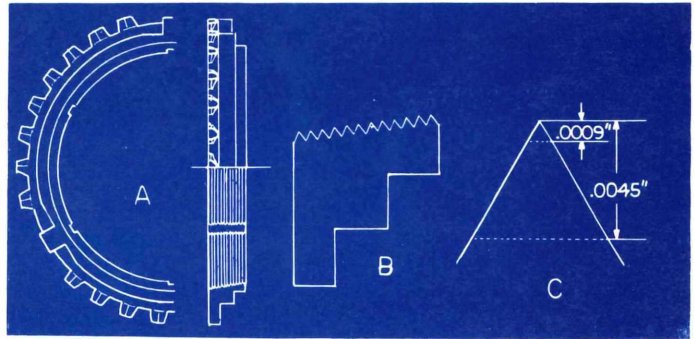


Figure 1 - Synchronizer Clutching Teeth

SYNCHRONIZER LIFE-SPAN

Figure 1 shows a BMW synchronizer and b shows small teeth on the inside of the synchronizer ring. These small teeth form the clutching surface between the synchronizer and the gear cone.

As the small teeth wear the gear takes longer to match the synchronizer speed, resulting in progressively slower shifts. The BMW synchronizer is considered to be worn out when the teeth are worn down more than nine/ten-thousandths of an inch (0.0009"). With the Ultimate Transmission this wear limit has been extended to forty-five/ten-thousandths of an inch (0.0045") (Fig. c). [These measurements correspond to .031" and .001" respectively, measured between the base of the synchronizer and the top of the gear.] Since the tooth form becomes wider as it wears, the rate of wear decreases geometrically. In other words, by allowing five times the amount of wear, we allow 25 times the wear area. This increases the clutching action of the synchronizer to enable very quick up and down shifts, even under racing conditions, without the need for any pause between gears.

The above concisely details the intense "zeroing-in" we've done on the two shortcomings of the BMW transmission. We've spent the last 4 years curing the disease that attacks these transmissions, rather than just rebuilding them to original condition and telling owners how to baby their gear boxes. Our modifications are what single out the "Ultimate Transmission" as the state of the art in rebuilds. Equally unique is our warranty: a two year unlimited mileage warranty covering synchronizers as well as bearing failures. And we don't care if you race your BMW — we race ours! (Reprinted from April '85 issue of BMWCCA Roundel.)

Send "Ultimate Transmission" and "Fuel Injection" orders and inquiries to METRIC MECHANIC INC.
SHIPPING: 1907 Truman Road, Kansas City, Missouri 64127
MAILING: P.O. Box 22012, Kansas City, Missouri 64127
Phone: (816) 842-7232

A FUEL INJECTION REVELATION

..."a **common sense** service method...diametrically opposed to the 'unit replacement' approach popular today."
(forward)

"Your car is the very **best diagnostic tool** available."
(page 8)

"Beware of the phrase: '**That's just the way these cars run**.'"
(page 8)

(In the Priority Trouble-Shooting Guide)... "there is an **assigned probability** to each particular cause as being the one solely responsible..." (page 9)

..."outlines the necessary steps to **re-synchronize** the warm-up regulator to coincide with cold engine operation requirements..." (page 49)

"The air flow meter can be **recalibrated** to match the ...requirements of your engine." (page 112)

"The constant opening and closing of the valve against the seat (of the L-Jetronic injector, keeps)...both surfaces free of carbon." (page 140)

(Since K-Jetronic)... "injectors are open constantly, an accumulation of carbon forms between the needle and seat..."
(page 46)

OVER 50 TECHNICAL ILLUSTRATIONS